The AMSAT® Journal

Editor
Russ Tillman, K5NRK
Editorial Staff
Ron Long, W8GUS
Buzz Gorsky, WH6I
Andy Reynolds, WD9IYT

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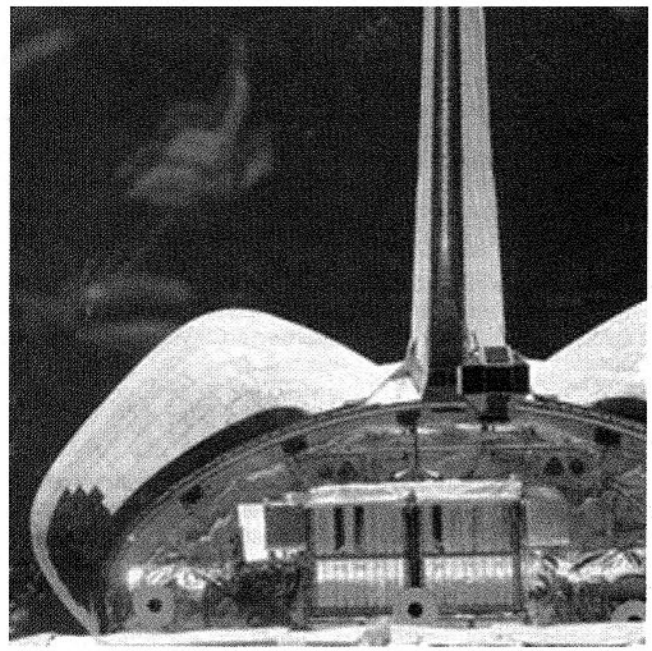

PANSAT being released from *Discovery's* cargo bay during the STS-95 mission, 29 October 1999 (NASA photo)

PANSAT – The Petite Amateur Navy Satellite

Steven R. Bible, N7HPR (n7hpr@amsat.org)

Dan Sakoda, KD6DRA (dsakoda@nps.navy.mil)

The Space Systems Academic Group at the U.S. Naval Postgraduate School (NPS) in Monterey, California has developed a small satellite for digital store-and-forward communication using spread spectrum techniques. NPS looked toward the Amateur Radio community in an effort to use cost-effective engineering and proven means of radio message relay. This cooperative initiative between NPS and the Amateur Radio community provides numerous benefits for the education of NPS students and the spacecraft will provide Amateur Radio enthusiasts a new space communication mode utilizing spread spectrum modulation **[continued on page 4]**

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850 Sligo Ave., Silver Spring, MD 20910-4703
Telephone: 301-589-6062 Facsimile: 301-608-3410
AMSAT-NA Club Callsign - W3ZM
AMSAT-NA WWW: http://www.amsat.org

The AMSAT Journal Staff
Vice President, Publications: Russ Tillman, K5NRK
Circulation: Martha Saragovitz
(martha@amsat.org)

Editorial Staff
Ron Long, W8GUS
Buzz Gorsky, WH6I
Andy Reynolds, WD9IYT

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Editorial Office: Russ Tillman, K5NRK, 113 Rollingwood Drive, Vicksburg, MS, 39183-9571, Internet: *k5nrk@amsat.org*, telephone and fax: 601-634-6398.

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Apogee View

Rocket Science

By now, I trust most of you have learned that the Phase 3D Project Leader, Dr. Karl Meinzer, DJ4ZC, and his team in Germany were in final negotiations with a launch agency for the eventual launch of the Phase 3D satellite. Needless to say, this news has been greeted with much joy among members of the International Phase 3D Project Team, as well as among our respective AMSAT memberships. Hopefully, by the time you read these words, a launch contract will be in place and the Team can start looking ahead to the final chapter of this nearly ten year saga.

However, amid all the (justifiable) joy at this news, we are still a very long way from having an operational satellite safely in orbit. As anyone who works with satellites and launch vehicles on a daily basis will tell you, a completed satellite sitting on the ground at a launch complex is still a far cry from having it up and running in Earth orbit.

That is, despite the very best efforts of a lot of very talented people, the business of building, testing and launching a satellite....any satellite...still has a great deal of uncertainty associated with it. One would think that after all these years of building and launching space hardware that the worldwide space industry would have (finally!) learned how to "get it right"every time. However, all one has to do is scan some of the recent reports in the space press to learn that this is simply not (yet) the case.

If my association with AMSAT and the Phase 3D Project over these many years has done nothing else, it has given me a much deeper appreciation for the uncertainty that's involved in building and successfully orbiting complex spacecraft. I believe at least part of the reason such endeavors must, of necessity, carry no guarantee is because a fully realistic simulation of the actual launch and space environment a satellite will ultimately encounter is nearly impossible to duplicate here on Earth.

That is, despite all the advances is space science over these past decades, there is still no real substitute for designing and building hardware, writing and loading software into that hardware and then launching it all into space to see if it actually works as intended. And, yes, this fact still holds true for the well-financed "big boys" in the space industry just as much as it does for us.

Over these past few years, a number of people have asked me to speculate on the risks involved in getting Phase 3D safely to orbit. I quickly remind them that, like most other space projects, its not a matter of just risk! Risk can usually be predicted by a mathematical probability function based on past experiences. Rather, a good portion of the Phase 3D project extends well into what I call the "squishy realm of uncertainty." We simply won't know for sure how well Phase 3D will perform until it is actually put in space and powered up.

Fortunately, most of the critical systems and subsystems that will fly aboard Phase 3D are copies (or are the next generation) of proven hardware and software designs that have successfully flown on previous AMSAT satellites. In addition, where it was prudent and affordable, the Phase 3D Design Team added a number of redundant transmitters, receivers and other back-up systems to the spacecraft to help reduce "single point failure" concerns.

But, the fact remains that even redundant systems add complexity to a design, which further adds to the overall uncertainty that things will all perform in space "as advertised." Phase 3D also contains a number of new structural, thermal and stabilization systems and equipment, including deployable solar panels, as well as some newly designed electronic, mechanical, and propulsion components. Many of these designs have never before flown in space on an AMSAT satellite.

Some people have argued that Phase 3D "puts all our eggs in one basket." However, as with most other AMSAT satellite projects, our past history has shown that it is the *nature of the launch opportunity* that usually drives the design of what AMSAT ultimately flies. Phase 3D has been no different in that regard. You will recall that it was The European Space Agency (ESA) who first offered AMSAT-Germany (AMSAT-DL) a unique and very affordable launch opportunity to carry a much larger and far more complex Amateur Radio satellite into a high elliptical orbit. AMSAT-DL accepted ESAs gracious invitation and the Phase 3D project was born. ESA's offer allowed AMSATs international team of designers and constructors to build capabilities into the Phase 3D satellite that had never been attempted before. Unfortunately, this also meant that a lot of new designs (and therefore a lot of uncertainty about how those new designs would work in the harsh environment of space) would also, of necessity, have to go along for the ride.

Yet, despite these uncertainties, the members of the International Phase 3D Team remain unanimously optimistic that Phase 3D will function as intended once it is successfully launched. To help reduce some of this built-in uncertainty even further, the Phase 3D Team has recently been subjecting the completed satellite to extensive ground tests. These tests use many of the same facilities and grueling test procedures that are also used on commercial satellites of similar size and complexity.

And, so far at least, Phase 3D has ultimately passed each of these ground-based tests with flying colors.

This fact in and of itself, is a strong tribute to the talents and dedication of those many persons on the Phase 3D Team who have labored long and hard to make sure that Phase 3D is as robust and reliable as they can possibly make it given our limited resources. Ten, twelve, and sometimes fourteen hour workdays for months on end (not to mention *several* months at a time away from home and family) for many of these people have now become the norm rather than the exception. And, where critical or specific skills weren't available on our volunteer teams, your AMSAT managers brought in the best outside knowledge and expertise we could possibly muster without also bankrupting our respective (and limited!) budgets.

Of course, none of this could have happened without a lot of very generous and sustained financial support from a lot of wonderful people. For it's been *your* outpouring of financial and other support that has allowed us to turn the dream of Phase 3D into reality and that has enabled the international AMSAT organizations to take full advantage of a once-in-a-lifetime opportunity.

However, despite *all* the rigorous ground testing the Phase 3D Team has now given the satellite, those tests will still fall short of duplicating the actual environments it will encounter on its first and only journey to Earth orbit. Naturally, well be uncertain that all will go according to plan, even as the launch agency gives it ***their*** very best shot at safely launching Phase 3D for us. But, even after Phase 3D is successfully placed in orbit, we still won't know for sure that our satellite will perform "as advertised" in the harsh environment of space until long after it is safely tucked into its final orbit and has undergone many months of maneuvering and extensive, on-orbit checkout.

So, as we look forward with eager anticipation to Phase 3D's eventual launch and operation, I believe it is important for each of us to pause for just a moment and reflect on a simple and enduring truth that has often been expressed in various ways and in various venues when speaking about the space business:

"Despite the very best efforts of some of the best and brightest people, the ultimate success of any space project will still be rooted deep within the realm of "rocket science", complete with all the squishy uncertainty such lofty pursuits demand."

——Keith Baker, KB1SF ■

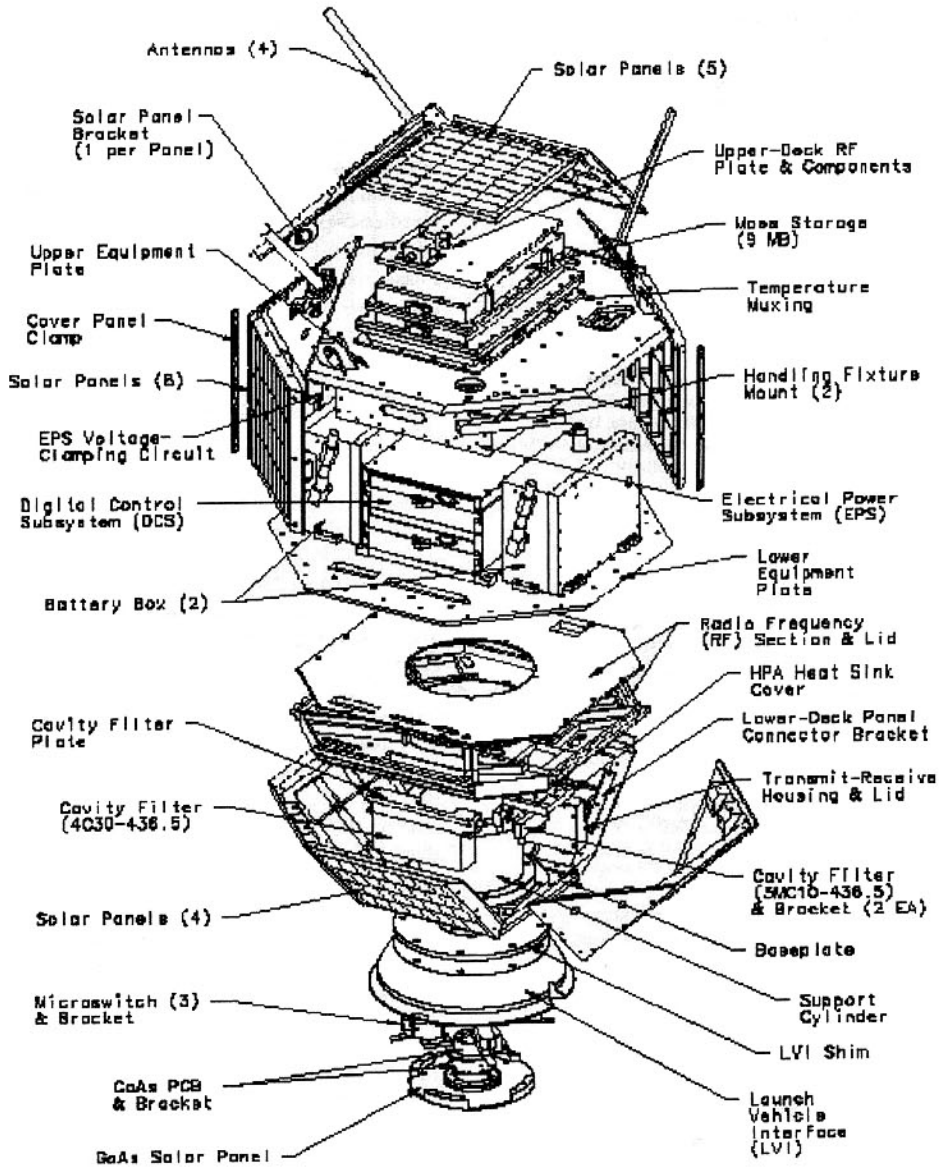


Figure 1. An expanded view of PANSAT.

[PANSAT continued from page 1] for packet radio. It also offers a means of evaluating spread spectrum in the increasingly congested frequency bands.

The Petite Amateur Navy Satellite (PANSAT) provides a proof-of-concept for store-and-forward communication on a small satellite using spread-spectrum modulation techniques. PANSAT is a tumbling spacecraft with a weight of 125.5 pounds and was completed in April 1998. The spacecraft will supply direct-sequence, spread-spectrum modulation with an operating center frequency of 436.5 MHz, a bit rate of 9.84 kilobits per second and 4.5 megabytes of message storage. On 29 October 1998, PANSAT was released into low-Earth orbit via the Discovery Shuttle (STS-95) under the Hitchhiker program as part of the third International Extreme Ultra-violet Hitchhiker (IEH-3) payload. PANSAT was on board the same shuttle mission (STS-95) that Senator/Astronaut John Glenn flew. The launch placed PANSAT into a circular, 555 km altitude orbit with inclination of 28.5°. The spacecraft is expected to have a four to six year mission life depending on the life of the batteries while PANSAT's orbital lifetime is expected to be upwards of ten years.

Educational Opportunities

PANSAT offers students an opportunity to gain practical education in Space Systems Engineering and Operations by way of

Master's degree theses, class projects, and directed study courses. PANSAT development combined the goals of education with technology application. The topics of graduate work varied and yielded a system-wide scope with exposure to real issues of design, development, integration, testing, and scheduling. Topics covered include mission operations, astrodynamics, mechanical and electronic subsystem design, system integration, software development, and proto-flight testing. While in orbit, PANSAT will provide both a means of evaluating the communication payload as well as a space-based instructional laboratory. As of June 1999, approximately 50 PANSAT-related theses have been completed.

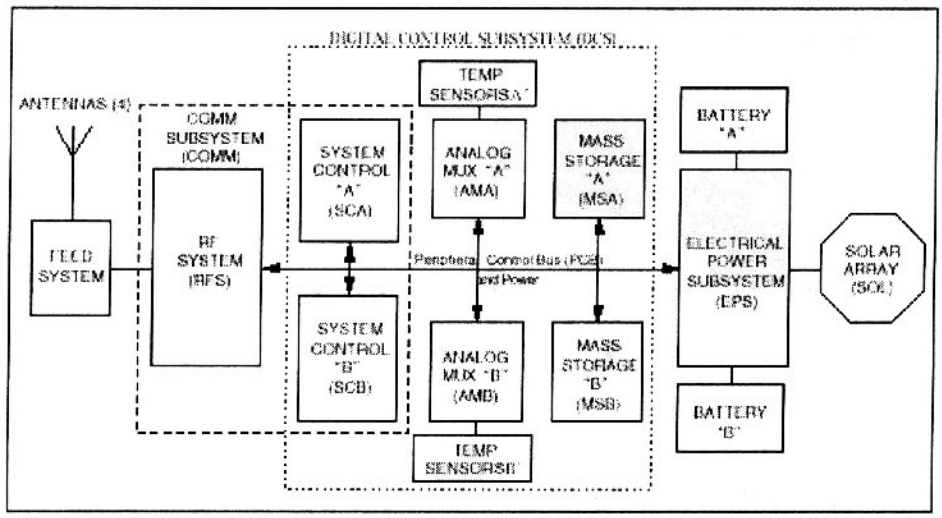


Figure 2. PANSAT system block diagram.

Spacecraft Configuration and Design

PANSAT has a robust structural design with high margins of safety and is adaptable to a number of launch vehicles. The satellite is approximately 19 inches in diameter and has no attitude control or propulsion. Eighteen square and eight triangular aluminum panels make up the outer surface of the satellite. Seventeen of the square panels are equipped with silicon solar panels and one gallium-arsenide panel is attached at the bottom of the launch vehicle interface (LVI). Four dipole antennas are attached in a tangential turnstile configuration to the triangular plates on the upper section. The spacecraft interior structure is composed of two equipment plates and a cylindrical support. Figure 1 shows an expanded view of PANSAT. The structure design consists of an aluminum housing and equipment plates in an approximately spherical configuration. The main load-bearing structure is a thin-shell cylinder supporting the lower equipment plate and attached at the baseplate where the interface occurs. PANSAT used a NASA standard ejection mechanism for hitchhiker payloads to deploy the spacecraft. The three main spacecraft subsystems are: communication (COMM), electrical power (EPS), and digital control (DCS). Figure 2 shows a system block diagram of PANSAT subsystems.

Spread-Spectrum Communication Payload

The communication (COMM) payload is simplex, or half-duplex, having a single channel for both up-link and downlink. The data rate is 9.84 kilobits per second. The spacecraft operates at a 436.5 MHz center frequency in the Amateur Radio 70 cm band. The pseudo-noise (PN) code sequence, in accordance with present rules and regulations, is implemented using a seven-bit shift register with taps at 7 and 1. The PN code is mixed with the data stream at a rate of 1 sequence length per bit of information, or 127 chips per bit. The spread signal is then modulated using binary-phase-shift-keying (BPSK) and up-converted to the transmitted carrier with 2.5 MHz of bandwidth. The spacecraft transmitter is capable of varying the output power to allow only the minimum required energy for successful reception. The spread spectrum receiver provides signal detection, tracking, and demodulation for recovery of the digital bit stream. The communication payload passes the data stream to a serial communication controller (SCC) for de-packetizing and error-checking of the CRC (cyclical redundancy check). The recovered data is then delivered to the spacecraft microprocessor. Both the modem and processor boards are located in the DCS System Controller (see Figure 2). The receiver is capable of receiving a carrier of at least -120 dBm signal strength. Link analysis shows the required transmit effective isotropic radiated power (EIRP) of the satellite to be 0.756 W and the ground station 2.65 W. The analysis assumed a Shuttle orbit altitude of 390 km and probability-of-bit-error of 10^{-5} or less. The satellite transmitter is designed to provide at least 2.0 W, and be able to step down to the minimal power required for acceptable probability-of-error, and should compensate considerably for a Rayleigh or Rician fading channel. The antenna on the spacecraft is an omni-directional tangential turnstile antenna with 4 monopole whips and 0 dB gain. The ground station antenna is assumed to be a standard commercial antenna with a gain of 15 dB. Communications with PANSAT from the NPS ground station, although useful, have not consistently been successful. Although the PANSAT antenna configuration was designed to provide a nearly isotropic radiator, actual open-field tests prior to launch showed a *pear-shaped* radiation pattern with maximum variations of +/- 4 dB of gain. These extremes were along the axis of symmetry with the peak in the direction toward the LVI and the deepest null pointing toward the top of the spacecraft. Because PANSAT is a tumbling satellite, there is no way of predicting how the spacecraft is pointing towards the NPS ground station. Additional losses can be attributed to polarization losses and thermal noise injected in the main beam of the ground station antenna because of the low-elevation constraint (approximately 27° max.) from the NPS ground station to the satellite. Furthermore, a dimensional error discovered late in the integration process at NASA Goddard Space Flight Center forced the antennas to be bent in order to remain within the payload volume of the Hitchhiker canister. This late modification to the antenna configuration could not be tested, but analysis indicates a similar but exaggerated radiation pattern.

The COMM payload consists of two direct sequence spread spectrum transmitters and receivers. Each unit is capable of switching from spread spectrum modulation to narrow-band binary-phase-shift keying (BPSK) transmission/reception. This allows for contingency operation and NPS command. A spread spectrum telemetry beacon will be provided initially for those in the early stage of setting up their spread spectrum ground station equipment. The COMM payload is designed using commercial off the shelf (COTS) components. Radiation-hardened components are used only in critical subsystem areas.

Electrical Power Subsystem

The electrical power subsystem (EPS) consists of solar cells for primary power, nickel-cadmium batteries for eclipse power, and power regulation/conditioning circuitry. The EPS relies on the main spacecraft processor for activating relays and for determining charge levels and charge cycles. Power is provided through an unregulated 12V ±3V bus and regulated at each subsystem module. A shunt regulator was not implemented in the design since the solar array voltage will never exceed the maximum input voltage of any subsystem DC-DC converter. Both nickel-cadmium batteries were fully discharged prior to launch to ensure the payload was inert while in the Shuttle. Following deployment, PANSAT boot software functioned flawlessly, controlling the EPS to charge the batteries. On-orbit battery usage suggested ways of improving battery charging to extend battery life. Most notably, PANSAT data showed that while one battery is being used for operation, the other requires only about $1^2/_3$ orbits out of five or six orbits to charge. By using a pulse-width-modulated charging scheme to lessen the impact on charging, battery life may be extended.

Silicon cells were selected for their low cost and adequate power efficiency. A minimum efficiency of 14.5 percent at AM0 (air mass zero) and 28° C was deemed adequate based on initial power budget estimates. 17 silicon cell panels cover the spacecraft providing an average area of approximately 1209 cm^2. Each panel consists of 32 cells with dimensions 1.92 cm x 4.00 cm connected in series. The panels were fabricated using the K6700 silicon cell with back-surface field and back-surface reflector (BSFR). An additional Gallium-Arsenide (GaAs) solar cell panel was added to allow power conversion in the case where the launch vehicle interface (LVI) is pointed at the sun. This GaAs panel takes advantage of Shuttle payload user volume between the LVI and the ejection mechanism.

Digital Control Subsystem

The primary functions of the digital control subsystem (DCS) are to provide control of the EPS, control and operation of the COMM payload, gather and store telemetry data, and perform memory management and control for message handling. The DCS consists of fully redundant control boards, each run by a M80C186XL microprocessor. The design of the DCS has gone through a number of iterations by students at NPS in order to fulfill the functional requirements of PANSAT. The 80C186 microprocessor was selected for its proven architecture, radiation tolerance, low power consumption, availability of development tools, and its capability of supporting a multi-tasking environment. The memory used in the DCS is divided into read-only memory (ROM) which stores the bootable operating system, system error-detection-and-correction (EDAC) random-access memory (RAM) where the boot-up ROM program is loaded, and mass storage memory, or user memory, which stores messages and telemetry data. The DCS uses 64 kilobytes of system ROM, 512 kilobytes of EDAC system RAM, and 4.5 megabytes of user memory.

Static RAM used for messages and telemetry requires a constant supply of power. Thus, all information will be lost in the event of loss of power. A reliable, non-volatile memory system would be ideal, provided it is easily implemented and yields the same functionality as those components already identified. Flash memory promises the advantages of non-volatility, high cycle life (100,000 block erase cycles), access time comparable to dynamic RAM (DRAM), and high density. Half of one megabyte of Flash memory is available in the mass storage system, but cannot be relied on for system-critical data. The Flash memory is flown as an experiment and is currently used for storage of telemetry data. The DCS is capable of updates of the operating system since the bootable kernel is transferred to RAM. This allows the up-link of application software, or tasks, and takes advantage of the hierarchical level of the operating system. The DCS boots from a portion of ROM, located in high-memory (64 kilobytes), where a fully tested kernel, boot loader, and primitive tasks are stored. The DCS loads the boot-up kernel from ROM into the low memory of the 1 megabyte of addressable memory of the 80C186. The DCS then waits for a command from the ground to up-load the remaining full operating system from the ground. The operating system is multi-tasking, supporting concurrent tasks. Tasks

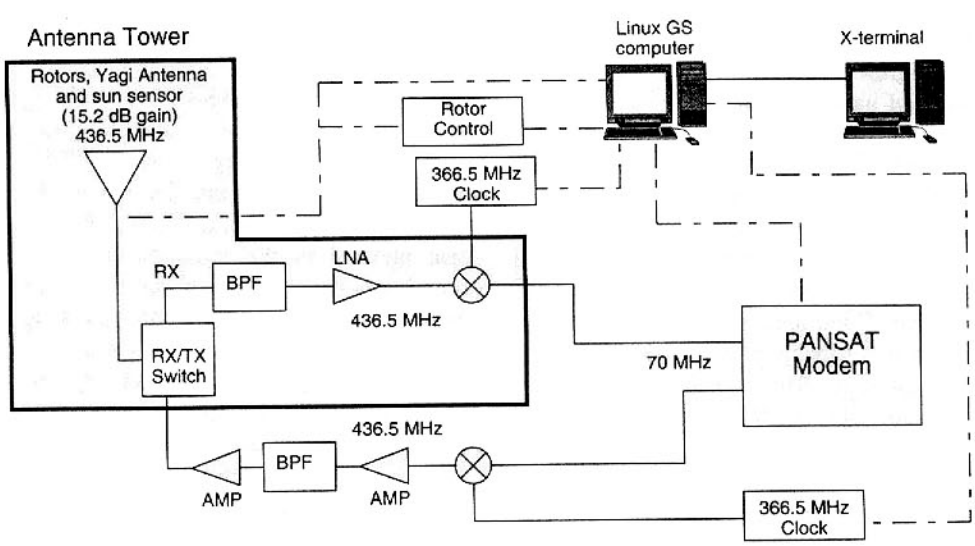


Figure 3. PANSAT ground operations.

communicate with other tasks via the operating system providing a powerfully flexible means of operation, software design, upgrade, and implementation. The AX.25 protocol is one such application task. Another task may be the request for telemetry data from the other spacecraft subsystems, or the implementation of mail services. Additional user services may be implemented as the spacecraft is utilized. In the event of a reset, however, the services of later versions of software will need to be reloaded.

Ground Operations

The command ground operations for PANSAT occur at NPS utilizing common Amateur Radio equipment and PANSAT-specific components for spread spectrum modulation. The NPS ground station has full command capability and telemetry data display software. Operational integrity consists of uninterruptible power and data backup facilities. A basic block diagram is shown in Figure 3. Ground tracking is done by the open-source *SatTrack* program using spacecraft ephemeris collected from the Naval Space Command and is, therefore, open-loop. The ground station is also required to perform Doppler compensation for both up-link and down-link transmissions.

The NPS ground station is required to connect with the satellite within a minimum three-day period. The low-Earth orbit permits a minimum of three daily windows of communication with NPS. NPS will down-link telemetry data that includes sensor data and operational status information including system administrative data. If three days have passed without NPS connection, the spacecraft will shut down all general users until connection with NPS is made. Telemetry data will be maintained during this time, if possible. Other contingencies may follow such an event if a hardware or software failure occurs. Telemetry data from sensors will be stored to provide a history of spacecraft performance. The most recent cycle of sensor data will be available for down-link. Other information in the telemetry package includes the spacecraft time, software statistics, operating system version, operations log including command execution and errors, and the mail box log.

PANSAT operations, recently, have been focused on garnering information on spacecraft performance for improvements to the basic ROM software. Many hurdles were overcome in the buildup of the ground station hardware, as well as software to assist automatic telemetry gathering and ephemeris updates. Because of many factors, including the tumbling nature of the satellite, deep nulls in the radiation pattern, and limited resources, development has not progressed as quickly as hoped. However, the spacecraft hardware appears to be working nominally, and work is progressing on spread spectrum aspects and user services software.

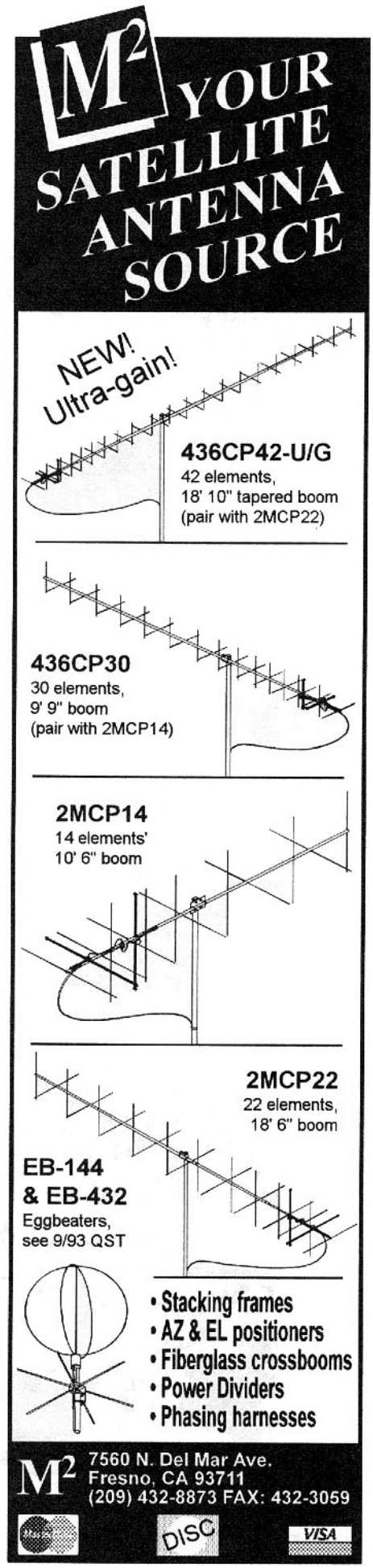
Potential Applications

The potential applications of digital communication via a spacecraft utilizing store-and-forward spread spectrum are numerous. Evaluation of the payload in its current configuration will help determine applicability for an operational system. Key points of the PANSAT design are its simplicity and low-cost. However, PANSAT does provide a sophisticated solution to message relay on a small space platform with the added advantages of a spread spectrum system. A number of examples of potential applications have been suggested for civil purposes. In its current configuration, PANSAT will provide a necessary means of communication to the Amateur Radio community to support public service communications, such as in times of natural disaster.

Summary

The testing of the Petite Amateur Navy Satellite (PANSAT) continues with the aim of providing a small low-cost, spread spectrum communication satellite for message relay. The PANSAT project is already successfully meeting its objective of providing meaningful educational experience for students at NPS. The specialized analytical skills nurtured through graduate thesis research are coupled with real-world issues of system design, integration, testing, and operations. Now in orbit, PANSAT will provide yet another means of instruction for space-based communication experiments.

Further information on the development of PANSAT can be followed from the Space Systems Academic Group World Wide Web server at URL *http://www.sp.nps.navy.mil/pansat/* ■



Phase 3D Roll-out and Vibration Tests

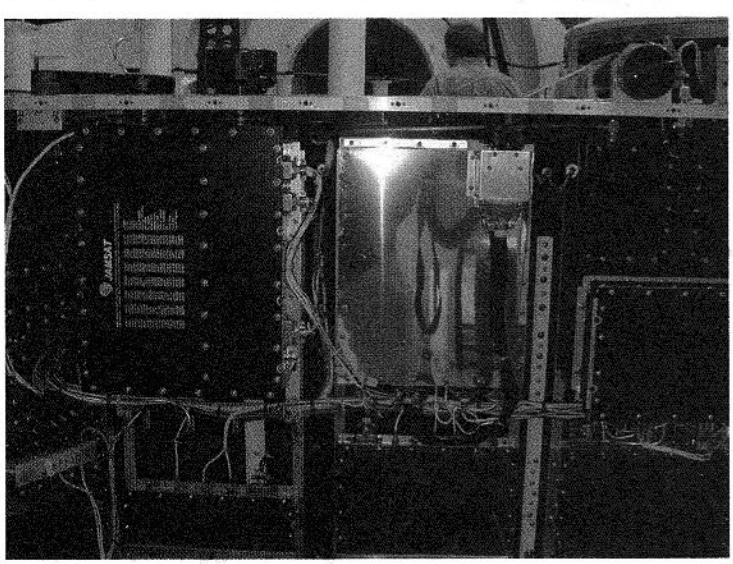
Peter Güelzow, DB2OS and Lou McFadin, W5DID

Ready to shake, rattle and roll, Lou McFadin, W5DID and Stan Wood, WA4NFY stand next to the *AMSAT Cadillac* upon arrival of the Phase 3D satellite at the Goddard Space Flight Center, Greenbelt, MD. (Note AMSAT's motto to the right of WA4NFY's head.) (photo by Tom Clark, W3IWI)

Beginning 13 June 1999, another series of major Phase 3D milestones were reached and completed starting with the successful test firing of the pyros to deploy the solar panels and testing of the control electronics for the 400N propulsion system. Rick Leon KA1RHL, who built the Array Release Unit (ARU) and Liquid Ignition Unit (LIU) electronics, observed the performance of the systems, while Peter Güelzow DB2OS programmed the spacecraft computer using the ground command station to fire the pyros. The Deployment mechanism, built by Bob Davis KF4KSS worked flawlessly and the Solar Panel was pushed open by the springs, when the pyro cut the Kevlar wire which holds the panel in place during the launch.

Roll-Out

After the solar panel testing, a team of experts and builders of the various transponders of the AMSAT Phase 3D satellite arrived from Europe, which includes Matjaz Vidmar S53MV, Mirek Kasal OK2AQK, Michael Fletcher OH2AUE, Wilfried Gladisch, Werner Haas DJ5KQ and Karl Meinzer DJ4ZC. Only Mirek's luggage did not make it and was lost somewhere over the Atlantic Ocean. After testing and calibration of the antennas, which were mostly built by Stan Wood WA4NFY and Freddy DeGuchteneire ON6UG, they were mounted to the spacecraft for the *rollout* when Phase 3D was transported outside for an *on air* test in full flight configuration. The spacecraft is protected from the Florida environment by a big sealed tent. After a most exciting few days of testing, the RF communications manager Werner Haas, DJ5KQ was happy to report to the Project Leader Dr. Karl Meinzer DJ4ZC the successful completion of the rollout and that all RF subsystems in the Phase 3D spacecraft worked nominally.



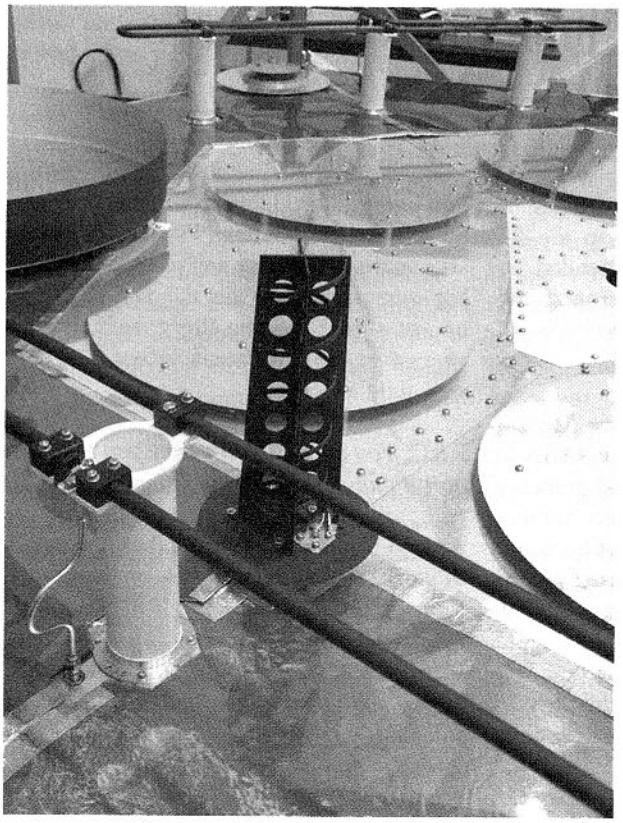
A close-up view of the JAMSAT camera (left) attached in a Phase 3D bay. Note the plaque attached to the camera recognizing the numerous persons involved in the JAMSAT effort. (photo by Tom Clark, W3IWI)

Another big event was the successful testing of the 400N thruster from MBB and the 100mN ATOS Arcjet developed by the University of Stuttgart, Germany with pressurizing of the whole propulsion system and fuel tanks. The test firing using Nitrogen gas was performed by Dick Daniels W4PUJ, Rick Leon KA1RHL, Karl Meinzer DJ4ZC and Peter Güelzow DB2OS.

Vibration Testing

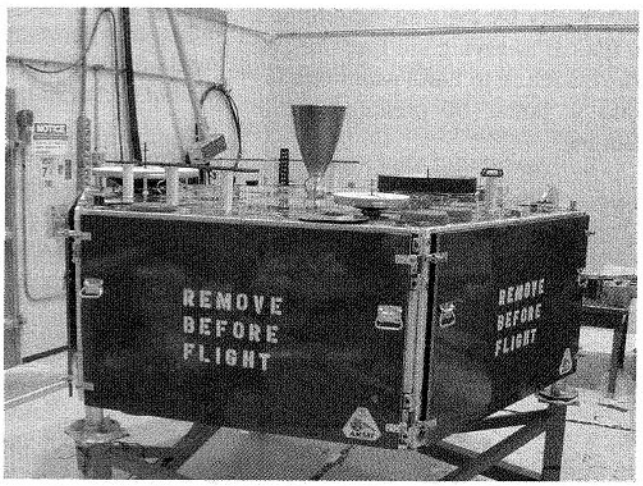
After roll-out, the next scheduled Phase 3D milestone is the spin balance and the vibration tests. The vibration test could not be performed earlier since the team had to wait for the final specification of the static and dynamic loads by the launch agency. To accomplish the vibration test, the Phase 3D satellite was transported in the *AMSAT Cadallic* (so dubbed by Tom Clark, W3IWI) to the Goddard Space Flight Center in Greenbelt, Maryland arriving on 13 July 1999. A dedicated team led by Lou McFadin, W5DID and Stan Wood, WA4NFY then prepared the spacecraft for vibration test which included installing of the flight solar panels. At the time this issue went to press, the vibration tests were progressing to a successful conclusion.

For additional photos and information on the Phase 3D vibration testing, see Tom Clark's, WWW page at htttp:www.clark.net/pub/tac/p3d.htm

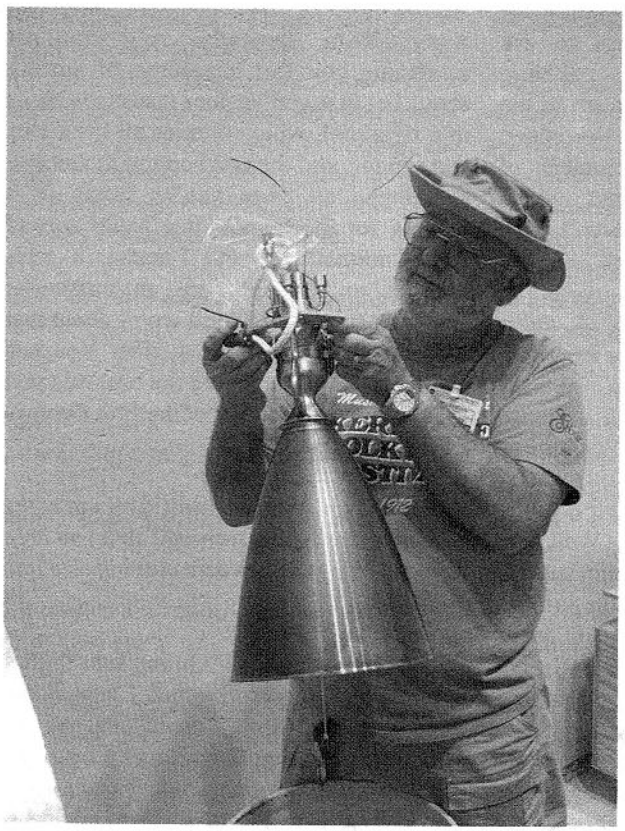


A close-up view of Phase 3D's extensive antenna suite. (photo by John Shew, N4QQ)

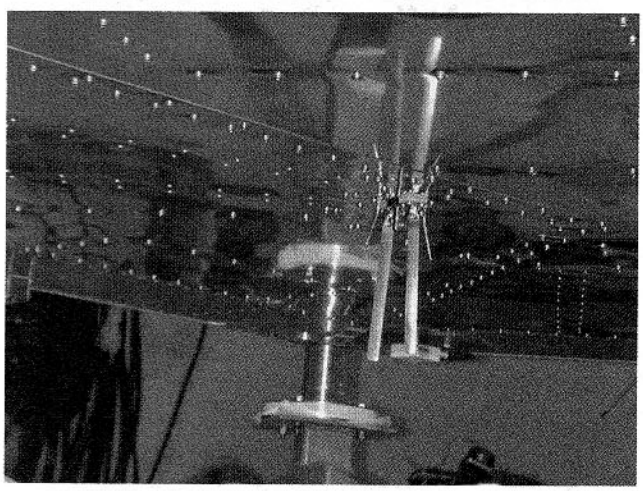
Stan Wood, WA4NFY assembling solar panels on Phase 3D for vibration testing. The protective flight covers remained on the solar panels during vibration testing. The panels will remain covered until launch. (photo by Tom Clark, W3IWI)



Phase 3D with solar panels installed and ready for vibration testing at the Goddard Space Flight Center, Greenbelt, MD. (photo by Tom Clark, W3IWI)



Lou McFadin, W5DID removing Phase 3D kick motor from its shipping container for installation on the spacecraft for vibration testing. (photo by John Shew, N4QQ)



A close-up *bottom* view of the Phase 3D spacecraft showing omni-directional antennas and arc-jet motor. (photo by Tom Clark, W3IWI)

A Chat with Andy Thomas

By Chris Edmondson, VK3CE

Editor/Publisher, *Radio and Communications Magazine*

So how does an astronaut — an Aussie one at that — really cope with all the hoopla and media attention? On a recent visit to Australia, we were lucky enough to score a one-on-one interview with ex-pat Aussie astronaut, Dr. Andrew Thomas, at Melbourne's Tullamarine Airport. Tapes rolling, we sat down for a chat...

This interview was taped back in October last year, a couple of months after Andy's return from several months in orbit in the Russian Space Station Mir, where he operated with the special event amateur call **VK5MIR**. It would be fair to say that Andy was pretty weary by the time he returned, and was quoted as saying the first thing he wanted on his return to Earth was a nice big pizza and a bottle of premium South Australian red!

His October trip to Australia was all business, although he later returned to spend a quiet Christmas and New Year at home with his family in Adelaide. For the first trip, he had a punishing four-week schedule of engagements and appearances. In the 21 days before I met him, he'd attended no fewer than 34 engagements around the country, and had addressed many crowded forums.

I met him just two days before he was scheduled to return to his work at NASA in the USA, by which time he would probably have been happy never to see another journalist or camera for the rest of his days! So I was very flattered and pleased indeed that he agreed to meet me, and more than a little surprised when he suggested he could fly over to Melbourne for the interview rather than have me drive all the way to Adelaide. In all honesty, I'd probably have *walked* to Adelaide to meet this man...

We exchanged pleasantries for a while and discussed our many contacts from space, then got into a few questions. As this is a pretty straight transcript of an informal chat, the questions are in no particular order. I'd not prepared a list of things to ask him before heading out to the airport. I've edited out a number of questions which really aren't very relevant...

Andy Thomas, VK5MIR on *Mir* from 22 January 1998 to 12 June 1998. (NASA photograph)

R&C: *I guess you'd be hoping to get up on the International Space Station one day?*

Andy: Well, at some point yes, but it's going to be a couple of years before they've got the crew rotations stabilised. It's also going to be a couple of years before they've got the construction all complete, so I think in the interim I'd like to do some Shuttle flights — you know, short duration flights. They're a bit less taxing right now. I'm kind of glad to stay on the ground for a while, too. I made a big commitment to do the last flight, of course — not just the flight itself, but the year of training in Russia before that, so it was quite a workout.

R&C: *You know, I don't envy you that part of it. I guess it wasn't much fun...?*

Andy: Oh it *was* a lot of fun, but it was a *lot* of work. So I'm keen to stay on the ground for a while.

R&C: *Okay, the takeoff... the first time you went up. No time to be nervous, I guess...*

Andy: No, you don't think about it that way...

R&C: *...the feeling when you take off in an aeroplane — it's a great buzz, a big shove in the back. Is it something like that, only a lot more so?*

Andy: Yeah, basically. And it's not something you feel any sense of anxiety about, because you've done it so many times in a simulator, which mimics all the sights and sounds, and the crew compartment and everything, so when you're sitting in it waiting for the launch, it actually sort of feels "normal" to you. I mean, it feels familiar to you. It's not an unfamiliar environment, so you don't worry about that too much. And it's a great ride! You just can't beat it. It's probably the best ride you can take in the latter part of the 20th Century I think.

R&C: *Are you able to see anything out of the windows during the take-off? Are you able to watch things as you take that big ride into space?*

Andy: Oh yes you can! On my first flight I actually took a mirror, which I held in my hand like *that,* and I could see out the window which was behind me. You could see down into the flame trench, you could see the engine exhausts, and you could see the launch pad rushing away as you went climbing up... All very interesting.

R&C: *Interesting is the word all right! It looks as though it gets under way fairly*

quickly once they let those clamp things at the bottom go.

Andy: There's eight bolts holding you down...

R&C: *They must be pretty big ones!*

Andy: Oh yes, they're big bolts, about this round (holds hands about six inches apart!); they're called frangible nuts actually. They have an explosive charge in them, which severs the bolt — breaks it — so you can go up.

R&C: *So when you get going, what is it? Up to about three Gs [three times the force of gravity during the 8.5 minute ascent] during the ride?*

Andy: Yes, three Gs is the maximum. That's what you get to right towards the end. The first part of it, though, is around 1.2 Gs initially, and it builds up. But they actually slow the engines down a bit — they throttle back the engines — to reduce the loads while still climbing through the thicker part of the atmosphere. Then once they're out of that, they bring the engines back up — called "Go throttle", where we throttle the engines back up — and you ride them and then of course the Gs slow back down again as the solid rocket boosters are depleting their fuel, so you lose your thrust. So once you've dumped them the G forces start going back up. And it just keeps rising and rising, and when it reaches three Gs they actually throttle back again and hold it at three Gs so they don't overstress the vehicle.

R&C: *Oh, that must be a heck of a buzz...*

Andy: It's a really great ride, it really is!

R&C: *Hey, you're only 400km or so up, but it's a hell of a way to travel that 400km!*

Andy: Well, you do get up there awfully fast...

We chatted a bit more, then moved on to the view from space.

Andy: Oh you can see the cities all right. The individual city lights stand out quite clearly actually. Several at once, like Adelaide, Sydney and Melbourne all at the same time. They stand out quite clearly...

R&C: *How often would you reach for a pair of binoculars and have a really good look? Obviously, you're not up there for a joy ride, and have a lot of work to do, but how often did you get the chance to use some really good field glasses while aboard Mir?*

Andy: Well, I didn't use the binoculars all that much, actually. I would mostly spend a bit of time at the windows with a camera, trying to get some interesting views. I used both a video camera and a still camera, but I did use the binoculars a few times...

R&C: *Tony [VK5ZAI] told me he'd borrowed from your Dad something like nine hours of video you'd shot...*

Andy: Oh really? Was there *that* much of it?!

Then we spent quite a while exchanging memories of the Mercury, Gemini and Apollo missions from our youth (we're about the same age), and I commented on how remarkable it was that all the astronauts who left Earth for the Moon actually not only got there, but made it safely back again given the technology of the day.

Andy: They were remarkable and captivating times, particularly given the computer systems for guidance. They had only one computer system, and it only had half an hour's worth of memory or something similar!

R&C: *You know, I suppose you must feel a bit short changed by the media nowadays. It seems that Shuttle launches get no more than a passing mention these days. At least NASA maintains a good Internet site...*

Andy: Oh, yes that's quite good, and we all get lots of crew photos to give away... here, have some of these. I'll sign them for you if you like!

Then we moved to the actual VK5MIR operation. This was a "special event" call arranged specifically for Andy's time aboard the Mir station. But that was while he was in the air. What about afterwards? Will he use his "home" call (US)? I asked about Andy's future involvement with Amateur Radio...

Andy: Yes, the VK5MIR call's gone now, unfortunately.

R&C: *Do you think it's a hobby you'll continue to have time for yourself, I mean on an ongoing basis?*

Andy: I don't know, I think... the way I see it right now is that I'd willingly use it for space flight, because it's really entertaining to be flying around the world and be able to talk to anybody, anywhere. You know, Africa, Australia, the US... everywhere! But the US was tough! It was pretty bad. They all wanted to talk at once! But it got busy coming over Australia too. Once the word got out that I was talking, and you published it in the magazine, it just went mad when I was over here too. They all figured it out I guess. At one point I had to stop for a couple of weeks, because it was just impossible.

It was funny, you know. Some people you'd talk to, they'd just want to make the contact, and say right, done it, bye, thanks! But other people would want to have a long conversation and take up the whole pass... [What, like me? Laughs.] Oh no, *you* were all right! You always did it at 2 or 3am and had a lot of questions for the magazine, so that was all right, but other people would do that at peak hour, and just wanted to talk and talk, and didn't seem to understand that there were a lot of other people who wanted to say hello too. They could take up the whole pass, and that was very frustrating.

R&C: *Oh well, maybe one day there'll be commercial space flights, so they'll all be able to get up there and say hello too! Somebody like me...!!*

Andy: Oh yes, I think there probably will be. There will be one day...

R&C: *What about Mars?*

Andy: Probably in 20 years...

R&C: *Reckon you'd go?*

Andy: I'd like to. I don't think it's going to happen in my professional lifetime though. By the time they do that I'll be... I mean, it's 20 years down the track, and I'll probably be out of it... I would like to go to the Moon, too, but I don't think that's happening any time soon — unfortunately!

R&C: *Of course, the Moon... Back in the late '60s and early '70s I found it incredible that we could watch those grainy black and white pictures on the TV. These days, of course, with digital picture transmissions and all that sort of stuff, the pictures would be almost perfect, but it was an amazing accomplishment for the day. You have to wonder what gear they might take now, and how they'd approach a Moon shot with late '90s technology...*

Andy: Yes, it really was pretty amazing, wasn't it, to watch those pictures coming back... Oh well, maybe one day...

R&C: *So you're back on the ground now. So what does an astronaut do in between missions?*

Andy: Oh, we support the flight program. I mean, there's other. The crews who *are* flying need support with their training, so we help them with all the procedures, simulator runs, help them with the launches, landings... So astronauts between flight assignments do that — provide the support for the other crews. Help with payload development, all that sort of thing.

R&C: *On one of the TV programs I watched they showed you at the public area watching a Shuttle take off. It must be a heck of a sight!*

Andy: Oh, amazing, remarkable, yes.

R&C: *How long can you hear it after it's taken off?*

Andy: It's interesting, you don't hear it at all at first. It's too far away. You see it going but there's no sound. I mean, the sound takes 20 seconds or so to get to you, then probably 30 seconds or so before it's so high that you can't hear it at all any more.

You know, you'd like a show that's coming up on the Australian SBS network next month. *(Well past us now, I'm afraid, but he was right. I did like it! VK3CE.)* Called 'The Astronaut', it was done by Beyond Productions in Sydney, and they actually came out to Russia and filmed a whole lot of my training in Russia, and then training for my flight in Houston as well, so they got quite a good summary of it all. I had a camera crew following me around for quite a while.

R&C: *Does it ever get that you feel like a goldfish in a bowl? I mean, all the media attention and stuff? To the point that you pine for some privacy every so often?*

Andy: No, it's fun to have people interested in it. I quite enjoy it. I recommend that you watch the show. It's quite a good summary of what it's like to go through the training and preparation, and has some great sequences of launches and docking in there with the Mir space station and things like that.

R&C: *You know, I must have mentioned in one of the stories that I'd been sending packet radio messages to you up there on Mir, and you wouldn't believe the number of readers who rang, wrote or E-mailed me to ask if they could have your E-mail address on Mir so they could send messages to you too.*

Andy: Ah yes, well we don't yet have that capability — the Amateur Radio's the only thing now — and it'll be a long time before we do, I'm afraid.

R&C *(looking at the crew photos again): Do you actually get to keep things like your space suits?*

Andy: Well, not *those* ones. Those ones are high altitude protection suits. They're actually very expensive suits. The cloth flight suits we do actually get to keep.

R&C: *What, a sort of track suit thing is it?*

Andy: Well no. They're for flying jets actually. It's Nomex. They're made of fire-retardant material. We get to keep those, but not these space ones. They get recycled and re-fly. I may get to keep my Russian space suit — the one that was so controversial — I may be able to get that donated to a museum here in Australia, which would be quite nice. NASA may be prepared to part with it... we shall see.

So that was about it. We then took a few photographs while we swapped a few more yarns. I noted that I'd heard Andy liaising with a couple of South Australian stations discussing his search for a suitable property to buy over there. At that point in time, he was still looking. As he said, "it's hard to do all that when you don't live here". Then, after asking about his plans to return to the USA (for a rest!) I rather tactlessly pointed out that he looked really weary and should stop at home for a break.

Andy: Well, I may extend my stay... that's the plan, anyway. It's been an extremely busy four weeks [the Australian tour], a very busy time. What I have *not* had in the whole time is a free uninterrupted day without having to do something, some official function, an interview or a speech or something like that. Oh, except last weekend. I had Saturday off!

R&C: *I reckon that surely what you'd really like to do about now is jump into the car, go find a nice view and sit there watching the clouds go past, wouldn't you? Or would it be a quiet afternoon with a beer and a pizza...?*

Andy: Well, I reckon that beer and pizza sounds pretty good...!

R&C: *What of the future for Andy Thomas? Do you reckon you'll wind up back here in Oz?*

Andy: I want to stay in the flight program for a while, and fly again, that's my aim. And use the radio up there again, of course.

R&C: *Well, it's time to wrap it up. I'm grateful that you made yourself available today. Look mate, I'd have to say that by dint of hard work you've done something that probably two thirds of people in our age group really hankered for — a real dream come true — and I'd like to congratulate you on your accomplishments.*

Andy: Well, thank you. It was a long path from Adelaide to Space Station *Mir*. It's a long way to travel, but the message to young people is that if you apply yourself *you can do it*. That's what I did, just focussed on the goal...

R&C: *Certainly you're only part of the way down your particular road. There's still a lot of travel left in you yet!*

Andy: I hope so, yes, but it's going to be tough to top the *Mir* flight though, in terms of uniqueness of the experience, and the response of everyone here in Australia to being so complimentary and excited by it...

A final note...

The day after I was due to run the image setter to produce this issue's pages, Andy, back in Australia for a holiday, attended a meeting in Adelaide to which he had invited all Australian amateurs who spoke to him in space to attend.

I made the trip by car, to hear this remarkable Australian present his talk and 20-minute in-flight' video, and to congratulate him on being named South Australian of the Year.

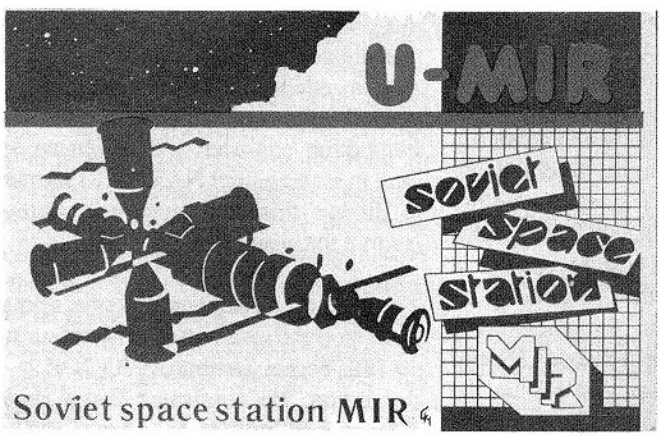
Editor's Note: This interview was originally published in Radio and Communications Magazine. Many thanks for Chris for allowing us to reprint this interview for Journal readers. ■

Mir QSL Cards

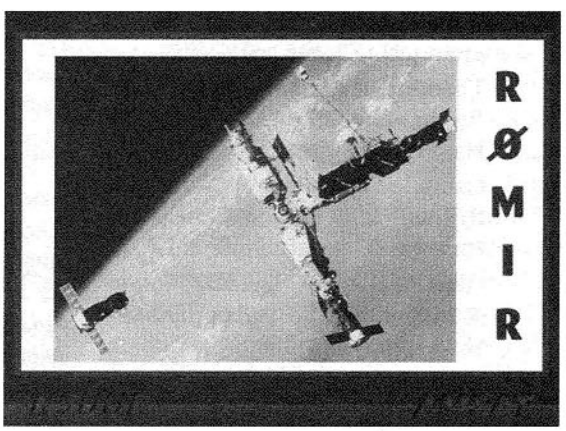
Andy Reynolds, WD9IYT

With operations on *Mir* soon coming to a close, it is appropriate at this time to take a look back at Amateur Radio activities from the station. There have been a number of fine articles dealing with the particulars of the different radio set-ups and their uses over the past several years, so this article will not rehash what has been so well covered. Instead, we'll look at the tangible rewards of operation through and to the stations on *Mir*.....you know, QSL cards!

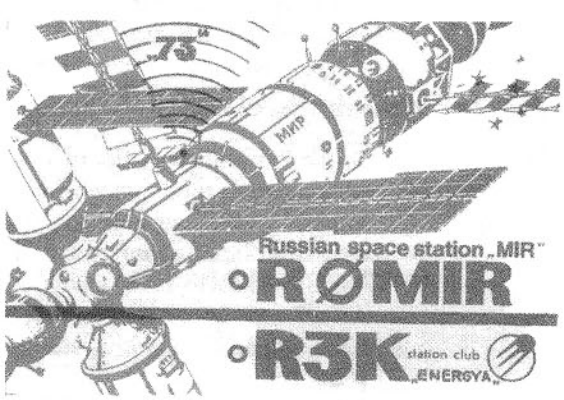
As with all special event cards, once the operation is over, the cards become more precious. To all of you who have managed to contact *Mir*, hold onto your cards and relish them. To all of you who haven't had the luck, don't lose hope as Amateur Radio on the International Space Station will provide a host of new opportunites. So keep up your hope, and sharpen your skills, new voices from space will be soon coming to an Amateur Radio near you!



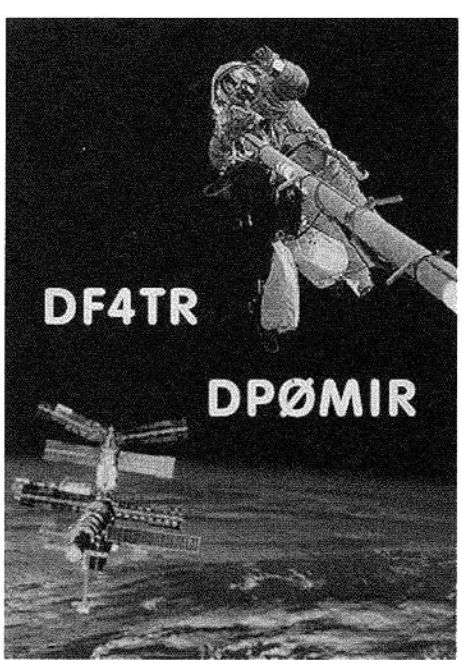
Several different QSL cards have been issued to hams from the special event stations and different operators from the start of Amateur Radio operations from *Mir*. One of the most widely issued cards is the simpler line drawing of *Mir* done in black and white with lettering in blue at different parts of the card. This card was provided by George Hopkins, K6GL, who received it for contacting U4MIR.



Another popular card is the R0MIR card, showing a black and white photo of *Mir* (taken, I believe, from a Soyuz capsule on docking approach). This version comes from Gary Bargholz, N9UUR, and as you can tell he is very proud of it!



IK1SLD keeps an interesting web page (http://www.425dxn.org), which carries images of the QSL cards he's received from contacts with *Mir*. This card was used by the R0MIR and R3K stations.



One of the more striking cards issued was for the DP0MIR station with it's color illustration of *Mir* and cosmonaut on EVA. The IK1SLD's 425 DX Group in Italy maintains a copy of this gem on their huge web page (*http://www.425dxn.org*). It is well worth the visit.

Joint NASA-Energia Meeting on Amateur Radio for the International Space Station
Held at the NASA Johnson Space Center, Houston, Texas
22-27 January 1999

Attendees

- Sergej Samburov, RV3DR, Representing Energia, AMSAT-Russia and ARISS-Russia
- Ron Parise, WA4SIR, Representing the ARISS-US Hardware Delegation
- Lou McFadin, W5DID, Representing the ARISS-US Hardware Delegation
- Frank Bauer, KA3HDO, Representing NASA, AMSAT-NA, and ARISS-US
- Matt Bordelon, KC5BTL, Representing NASA and ARISS-US
- Thomas Kieselbach, DL2MDE, Representing the ARISS-German Hardware Delegation
- Gabriele Kieselbach, DL4MIA, Representing the ARISS-German Hardware Delegation
- Alberto Zagni, I2KBD, Representing the ARISS-Italian Hardware Delegation
- Fabrizio Bernardini, I0QIT, Representing the ARISS-Italian Hardware Delegation
- Luca Bertagnolio, IK2OVV, Representing the ARISS-Italian Hardware Delegation
- Vladimir Fet, Russian Translator
- Carolynn Conley, NASA-Integration Engineer
- Ed Luu, KC5WKJ, STS-101 Astronaut
- Yuri Malenchenko, STS-101 Cosmonaut

Friday Morning, 22 January 1999

The meeting started with initial introductions by the NASA, Energia and ARISS members in attendance followed by an introductory discussion led by Frank Bauer, KA3HDO, Matt Bordelon, KC5BTL and Sergej Samburov, RV3DR. The introductory discussion described the primary objectives of this series of meetings. The objectives were to finalize the design development of the *Initial Station* Amateur Radio hardware for ISS and to develop a more effective understanding and advocacy of the Amateur Radio on the International Space Station (ARISS) program within NASA and Energia. Amateur Radio teams from the US and Russia both agreed that it has been a formidable task to develop an Amateur Radio station for ISS—some managers are not in favor of this on U.S. and Russian sides. The issues that plague the U.S. team working for NASA and the Russian team, working for Energia, are strikingly similar. The astronauts and cosmonauts want Amateur Radio on-board. Mr. Ruymin, director of operations at RSC-Energia, became a believer in Amateur Radio when it provided him the opportunity to communicate with his wife, a cosmonaut in space. The crew members have seen and experienced the benefits. However, this enthusiasm is not shared throughout the ISS program office in Energia or in NASA. Those who work for NASA and Energia have no way to charge their time when they work on ARISS. They have no travel authorization. ARISS has equipment to fly, an opportunity to fly hardware to ISS on the Space Shuttle, but only has an e-mail from a key NASA ISS official giving us the go-ahead to proceed. Frank Bauer cited the need for an official Memorandum of Understanding (MOU) between NASA and Energia, recognizing the need to develop Amateur Radio on ISS and ARISS's role as the sole integrator and operations coordinator of the Amateur Radio station. All in attendance agreed that this was needed. Carolynn Conley, the NASA Integration engineer, was given an action item to set up a joint NASA/ARISS meeting to discuss this and develop a strategy to resolve the issue.

The team then discussed Energia's progress to support the installation of Amateur Radio on ISS. Sergej Samburov, RV3DR led this discussion. He confirmed that 4 dual-use antenna feedthroughs have been installed on the Russian Service Module. These dual-use feedthroughs are expected to support Amateur Radio operations and ISS proximity video capability during Russian and U.S. spacewalks. This proximity video system is called Glisser. Prior to this meeting, several discussions had been held by the ARISS hardware team on potential antenna designs. The design concept described and agreed to include a VHF/UHF antenna and a Glisser antenna that will also serve as an Amateur Radio L and S band antenna. One of the four antenna systems would replace the VHF/UHF antenna with a to-be-defined HF antenna. Final antenna design decisions were scheduled for Saturday, 23 January 1999.

Sergej distributed a diagram (Figure 1) which depicts the Service Module and the antenna feedthroughs. He stated that cables have been installed internal to the Service Module to attach these 4 feedthroughs to the ARISS-coordinated Amateur Radio station. He said that the Service Module has no rack space for an Amateur Radio station. The ARISS station will need to be attached to the wall using Velcro near the "426" as shown on Figure 1. He highly encouraged all to start small and get bigger as the space station

Figure 1

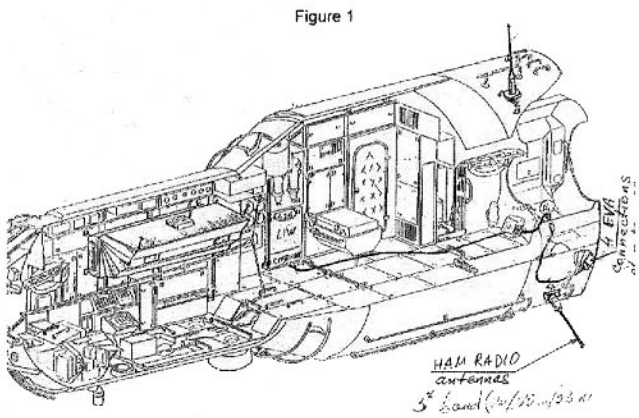


Figure 1. Diagram showing service module and ARISS antenna feedthroughs.

development progresses. The entire team in attendance agreed. Lou McFadin stated that the Initial Station development supports this position. Sergej then stated that all 4 antenna systems would be mounted on four different handrails near the back end of the Service Module. Figure 2 provides a rear-looking view of the Service Module with the antenna locations shown (WA1, WA2, WA3 & WA4). The antenna closest to the feedthrough is that located at WA3. The antenna installation would be accomplished through an EVA on the 2A.2 (STS-101) space station development flight. Mounting the antenna systems to the handrails would be accomplished using a *clothes-pin* type of handrail clamp. (See photos as Figures 3a, 3b, and 3c). This clamp would be provided by Energia. The antenna system, consisting of antennas, diplexer and the plate, which mounts to the EVA clamp, would be provided by the ARISS US and Italian teams. The Energia team could provide blanket material that could be installed on the antenna plate and over the diplexer. The antenna system interfaces were discussed. The specific interfaces and responsibilities are shown in Table 1. Sergej also described a special EVA connector, (Figure 4), which will be used to connect the two pigtail cables between the antenna system and the feedthrough.

The ARISS team will provide training hardware of the equipment to be housed in the Service Module. The ARISS team will also provide antennas and antenna mockups for EVA training in the Russian Hydrolab.

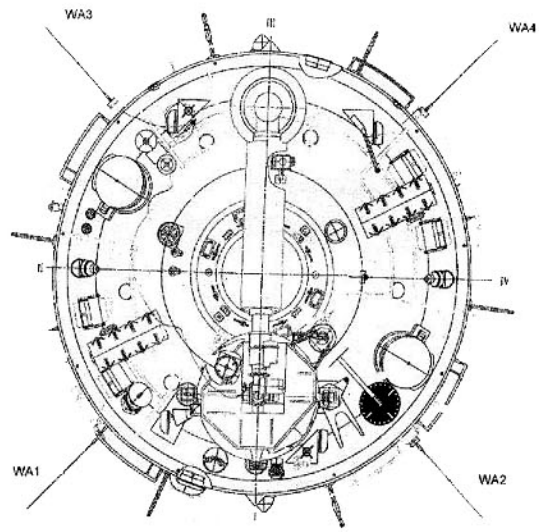


Figure 2. Diagram showing rear view of Service Module and ARISS antenna locations.

The team then broke for lunch.

Friday Afternoon, 22 January 1999

The afternoon session started with a tour of the Sonny Carter Training Facility followed by an EVA discussion with the STS-101 astronauts who will be installing the ARISS antenna system on the Service Module.

The tour of the Sonny Carter Training Facility provided the ARISS team members an opportunity to see the world's largest Neutral Buoyancy Facility see Figures 5 & 6). This facility, provides an underwater simulation of the zero-G environment. The facility has several underwater mockups of various space station modules. This facility is similar to the Hydrolab facility in Russia, where the ARISS antenna EVA simulations are set to occur. The ARISS team also had the opportunity to inspect several space station and *Mir* module mockups that are housed outside the Sonny Carter Training

Table 1. Antenna System Interfaces and Responsibilities

Item	Responsibility	Interface
Antenna System (Antennas, Diplexer, Plate)	ARISS Italian & US teams	Female N Connector
EVA Handrail Clamp	Energia/AMSAT-Russia	See Figure 3a, 3b, and 3c
Antenna System Thermal Blankets	Energia	N/A
Cabling from Antenna to Feedthrough (Note-includes special Russian EVA connector, connector in-between antenna pigtail and feedthrough pigtail)	Energia/AMSAT-Russia	Male N to Russian EVA
Service Module Feedthroughs (external feedthrough to internal panel 426)	Energia/AMSAT-Russia	Russian-internal
Pressurized Module Cabling (panel 426 to radio)	ARISS-US	Male BNC to Male BNC

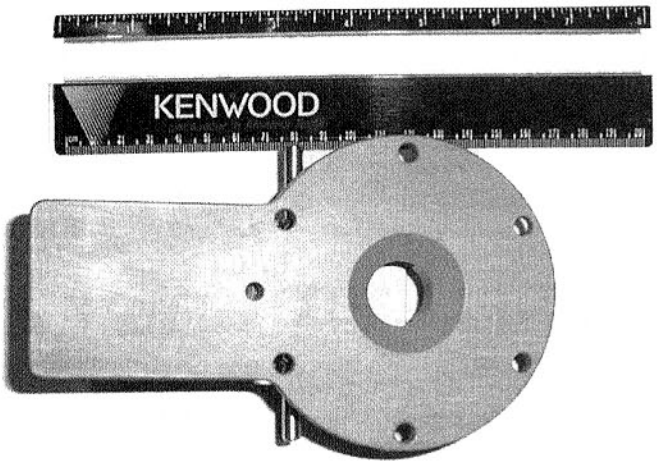


Figure 3a. Top view of antenna EVA handrail clamp.

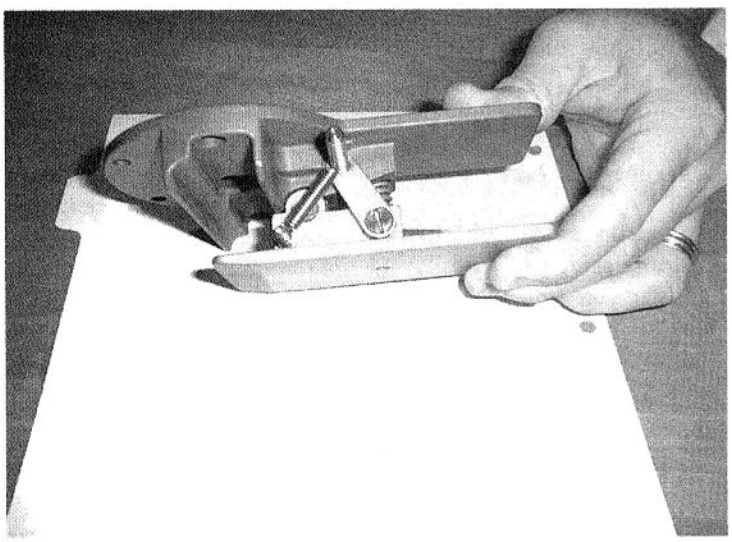


Figure 3b. Side view and antenna EVA handrail clamp.

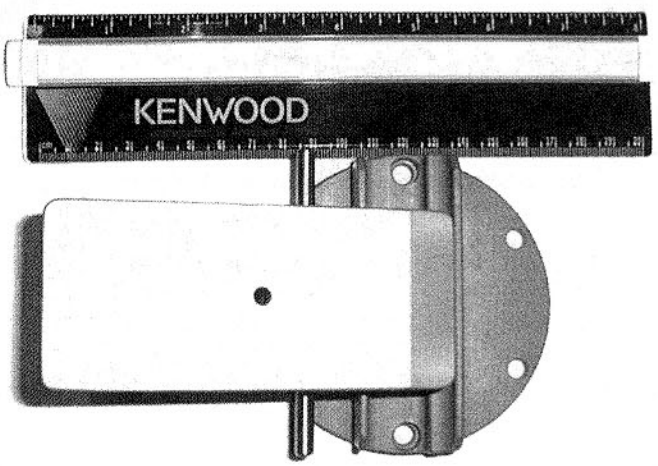


Figure 3c. Bottom view of antenna EVA handrail clamp.

Facility. This gave the team an opportunity to perform a close inspection of the Russian and US handrail designs that are to be incorporated on the ISS and upon which the ARISS antenna systems will be installed.

After the visit to the Sonny Carter Training facility, a meeting was convened to discuss the antenna installation EVA with the STS-101 astronauts who will conduct the EVA. Astronaut Ed Lu was in attendance. Several EVA clamps and holding devices were presented and demonstrated to the ARISS team by the EVA technical team. These devices were indicative of, but not identical to, the handrail clamps that will be used to install the 4 antenna systems on the outside of the Service Module. Astronaut Ed Lu was then presented the flexible and rigid VHF/UHF antenna designs and the specific design for the antenna system and asked for his feedback on the design options. He advocated the use of the flexible VHF/UHF design from a safety and simplicity standpoint. He stated that, from an EVA perspective, "The simpler the design the better." He stated that he and his STS-101 colleagues would be at the Star City Hydrolab next week. They will return to Russia in May for training. At that time they will need the antenna system mockups in-place at the Hydrolab. He stated that the crew wants to perform EVA simulations of the whole system, handrails, clamp, plate, coiled cable and connector for each of the 4 antenna systems. The 4 antenna systems and handrails need to be prominently identified so the crew will know where each will be installed. The mockup antenna systems must look as close as possible to the real system. Later in the meeting, Cosmonaut Yuri Malenchenko joined in on the discussions. Both Ed and Yuri stated that they would like to have the opportunity to perform the antenna EVAs and then perform a full end-to-end checkout of the ARISS initial station in the service module on STS-101.

Saturday, 23 January 1999

The primary agenda for Saturday was to finalize the antenna design, to solidify the antenna system interfaces and to define the quantities of systems to be provided and where they will be delivered. The antenna system proposed include a dual band VHF/UHF antenna, a microwave antenna system that will support the Russian Glisser requirement as well as Amateur Radio operations on L band and S band, and a diplexer. These two antennas and diplexer are to be mounted on a plate that attaches to

the EVA handrail-clamping device (Figure7).

The team first focused on the dual-band VHF/UHF antenna, where two different designs were presented. After receiving feedback from astronauts and cosmonauts and discussing the virtues of each design, the ARISS hardware team selected the flexible VHF/UHF antenna, designed by the US team, as the baseline design. This design, shown in the photograph (Figure 8), uses a flexible measuring tape covered with yellow Kapton as the driven element. A large circular piece of Delrin (PVC for the prototype) provides a solid mounting interface and houses the connector and attachment hardware. The design is very robust. It has no sharp edges and an astronaut can step directly on the antenna and it will snap back into place when the astronaut moves away.

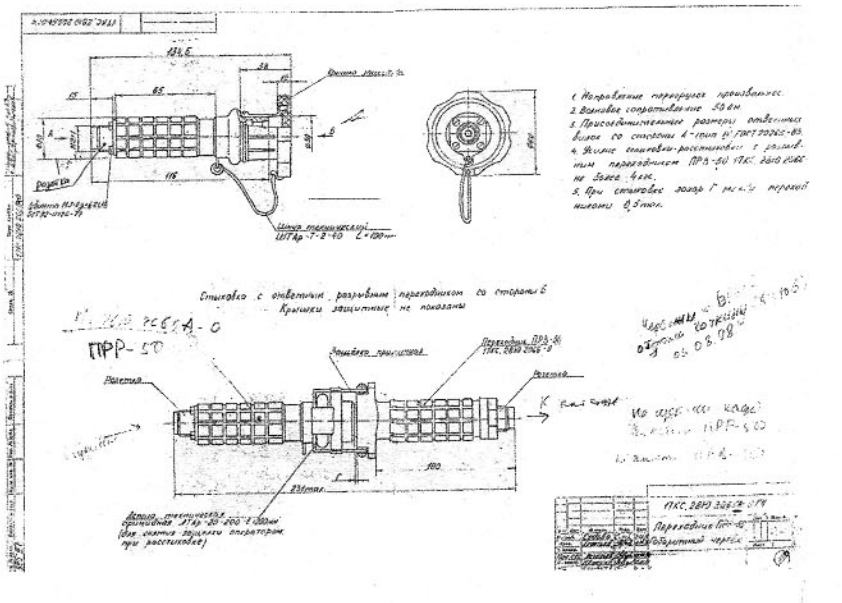


Figure 4. Special EVA connector for use in connecting pigtail cables between antenna system and feedthrough.

Sergej Samburov stated that the antenna system on ISS should support HF operations as well as the other proposed operating bands. Lou McFadin proposed the development of three identical VHF/UHF/microwave antenna systems and an HF/microwave antenna system. The antenna system design, shown in Figure 7, could replace a VHF/UHF antenna with a 2.5 Meter piece of flexible measuring tape to permit HF operations. This antenna system should be optimized for 10 meter operation and be able to support experimental use on 15 meters and potentially even 20 meters. Referring to Figure 2, Sergej stated that antenna location WA4 affords the best opportunity to install the HF antenna. The other three antenna systems would use the VHF/UHF antenna.

The microwave antenna system is being specified to support the Glisser needs at around 1.99 GHz as well as the Amateur Radio L bands and S bands. The current Italian microwave antenna proposal uses a wide band log-periodic antenna. This design can operate from around 1 GHz to about 2.4 GHz. Fabrizio Bernadini stated that, with a small change in the design, the antenna bandwidth could be extended to allow operation to approximately 10 GHz. The team debated whether a circular polarization requirement should be imposed. The final consensus was that it should. This led to a lengthy discussion of whether a log periodic or flat spiral antenna should be the baseline design. The decision on the specific antenna design was not made. Instead, the team debated the specific requirements that should be imposed on the microwave antenna design with the understanding that the Italian delegation would make the design trades and select a specific design that meets the antenna requirements. All agreed that the Amateur and GPS frequencies on this antenna are benefits that ARISS derives by making this a dual-use antenna. It is vitally important that the Glisser EVA requirements are met with this antenna system since it is a prime capability for ISS. The following requirements were imposed:

Microwave Antenna Requirements

- Italian delegation assume responsibility for antenna, phasing, harness

Figure 5. Above water view of the Neutral Buoyancy Facility at the Sonny Carter Training Facility.

Figure 6. The Neutral Buoyancy Facility is similar to the Russian Hydrolab Facility where ARISS antenna and EVA simulations are schedule to occur.

- Support Amateur L & S bands, GPS receive and Glisser operations. Bandwidth 1.2 GHz to 2.5 GHz
- Antenna should be optimized to ensure best performance for Glisser
- Glisser frequency bandwidth: 1.989-2.005 GHz. Max gain variation: +/- 3 dB
- Within 5dB of the Glisser gain, the following frequencies should also be accommodated:
  - 1260-1270 Amateur L Band
  - 2400-2450 Amateur S Band
  - 1176 GPS Receive
  - 1227 GPS Receive
  - 1575 GPS Receive
- Polarization: Left Hand Circular within 3 dB
- Power: 10 W up to 2.5 GHz
- Connector: SMA - Female
- Maximum Size: 250 mm x 250 mm x 150 mm

The diplexer design was discussed and requirements were generated. As shown in Figure 7, the diplexer will be mounted below the antenna plate and beneath the two antennas. A single design was suggested with a high pass filter for Glisser, L Band & S band and a low pass filter for HF, VHF and UHF. The specific requirements follow:

Table 2. Initial Amateur Radio Station Components in Pressurized Module

Description	Quantity	Part Number	Providing Organization
TRANSCEIVER (ERICSSON)	1	MP-A-VHF	US
POWER ADAPTER MODULE	2	SXISS98300	US
ADAPTER MODULE	1	SXISS98200	US
PACKET MODULE	1	SXISS98100	US
TRANSCEIVER CABLE	1	SXISS98400	US
ANTENNA CABLE	1	SXISS99403	US
ERICSSON CABLE	2	SXISS98401	US
HEADSET EXTENSION CABLE	1	SXISS99402	US
HEADSET-NOISE REDUCING**	1	40433G-01	US
ISS HAM 10A 28V DC POWER CABLE	1	SXISS99404	US
ISS HAM 3A 28V DC POWER CABLE	1	SXISS99405	US
PGSC RS-232C 9-PIN CABLE**	1	SED33103348-307	US
TRANSCEIVER UHF (ERICSSON)	1	MP-A-UHF	US
DIGITALKER/SPEAKER MICROPHONE	1	SXISS99500	Germany (Note 1)
SSTV	1	TBD	US (Note 1)
RF NOTCH FILTER	1	TBD	US (Note 1)

Note 1: To be flown on a flight after STS-101

Diplexer Requirements

- Common design for all 4 antenna systems
- Maximum input to diplexer:
  - 200 W on HF
  - 50W on VHF/UHF
  - 10 W microwave
- Low Pass Filter
  - Maximum Loss—20 MHz-500 MHz:
  - dB Minimum Attenuation-1 GHz and above: 50 dB
- High Pass filter
  - Maximum Loss-1 GHz-2.5 GHz:
  - dB Minimum Attenuation-500 MHz and below: 50 dB
- Maximum SWR through diplexer and antenna system: 2:1
- External connector: Type N Female
- Maximum volume: 360 mm diameter, 50 mm height
- Designed so can be bypassed if issues arise. This will result in the direct connection of the Glisser antenna (prime system) with the Glisser radio.

An interface diagram for the antenna system was generated and is depicted in Figure 9.

In the late afternoon, a picnic was held with members of JSC ARC. During the affair, the initial station hardware, to be delivered to NASA for installation on ISS Flight 2A.2 (STS-101), was demonstrated (Figure 10). This included a demonstration of the 2 meter Ericsson radio, the flexible VHF/UHF antenna, and all the interfaces.

Sunday, 24 January 1999

Sunday was set aside for a day of rest, relaxation and tours of Space Center Houston, where the team got to see the *Mission to Mir* IMAX movie. The Italian delegation completed their visit and returned home.

Monday, 25 January 1999

With the Italian team absent, attention focused on the Amateur Radio hardware to be installed in the pressurized module. The specific components to be flown as the Initial Station were decided at the July 1998 meeting in Surrey. Table 2 describes the

Initial Station hardware planned to be flown and installed inside the Service Module. As shown, the Initial Station will provide voice and packet capabilities on 2 meters and 70 cm. The adapter module was designed to support voice, packet and digitalker operations. Future SSTV operations were discussed. The Initial Station can support SSTV operations through the adapter module interface. The US-provided equipment depicted in Table 2 is currently manifested on STS-101. The Digitalker could be flown on STS-101, if it is ready before Mid-March. If not, it will be flown on a future Shuttle mission. One item not planned but deemed necessary is a speaker microphone. This feature will either be installed in the Digitalker or developed separately.

Software to be flown with the Initial Station hardware was also discussed. Sergej suggested the use of Winpac as a convenient auto-BBS for the packet system. Ron Parise took an action from the US team to obtain this software and evaluate it for use on ISS. Matt Bordelon stated that World Map will be installed on all the ISS computers and will be used in the Initial Station setup.

Sergej provided the US hardware team with a sample 10A power connector that is used on Mir and will be used in the Service Module. The Service Module provides 28 V DC. The voltage can vary from 34 V to 23 V. Lou McFadin stated that the U.S. Initial Station hardware can operate between 32V and 16V. An action was taken by the US team to determine if 34 V will damage the SAREX equipment.

The design of the Digitalker was presented by Thomas Kieselbach. There was a question regarding the fuses installed in the digitalker. Lou McFadin suggested that Thomas consider a polyfuse instead of a standard fuse. The polyfuse will provide the protection provided by a standard fuse but it does not need to be replaced if an overcurrent situation occurs with the digitalker. Thomas was given some polyfuse information and he intended to modify the Digitalker design to incorporate this enhanced feature.

The specific numbers of Initial Amateur Radio Station hardware sets required were discussed and are presented in Table 3.

Specific antenna systems required for flight and training were discussed. These are defined in terms of high fidelity systems that

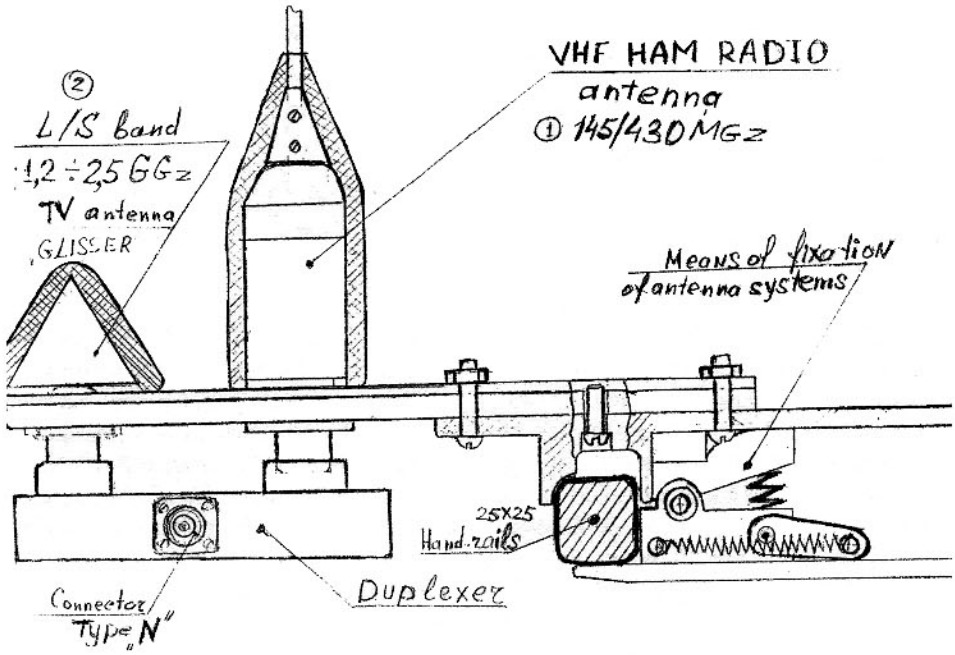


Figure 7. ARISS diplexer design.

can be operated (e.g. flight systems and operations training systems) and volumetric systems that cannot be operated (e.g. mockups for EVA training). Table 4 defines the systems required.

Tuesday, 26 January 1999

Sergej Samburov pointed out that Energia has not officially agreed to install the Amateur Radio equipment. They have the cables and feedthroughs ready. Sergej has generated the technical proposal document, the technical decision document, negotiated the resources required and has received signatures from approximately 75% of the Energia management. However, the system is not official until all the signatures and agreements are in place. This discussion led directly into the discussions with NASA on making ARISS an official capability on ISS.

Discussion with NASA on ARISS Official Status

A meeting was convened with Dennis Webb, the Associate Director of the Mission Operations Directorate to discuss various

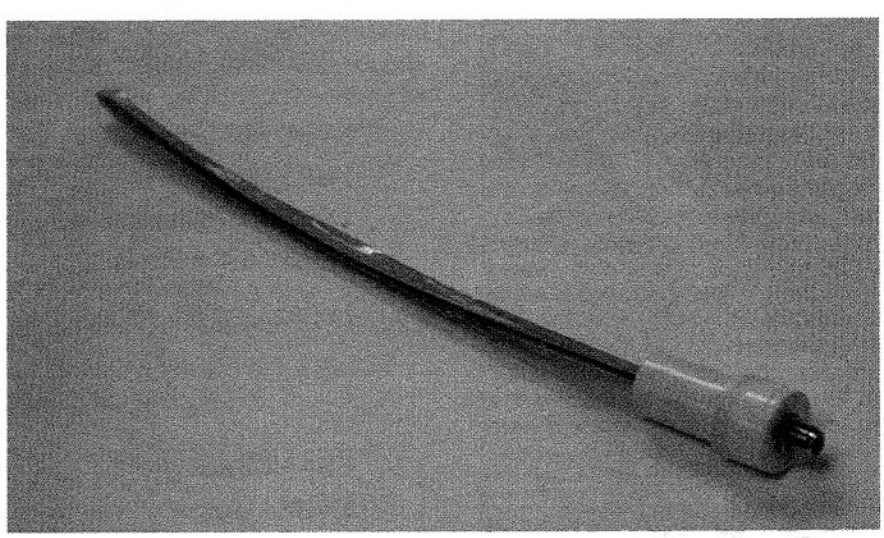


Figure 8. ARISS VHF/UHF antenna which is a flexible measuring tape covered with yellow Kapton as the driven element.

Table 3. Initial Amateur Radio Station Hardware Sets Required

Item	Description	Final Destination/Use
1.	Flight System	ISS/2A.2/STS-101
2.	Flight Backup System	U.S./AMSAT
3.	Training Unit	Russia
4.	Ground Station	Russia/Integrated Text Stand
5.	Training Unit	U.S./NASA JSC
6.	Testing Unit	U.S./AMSAT

options to make ARISS official within NASA and the Russian Space Agency. The lack of official status has resulted in some confusion within NASA as to who is accountable for the delivery of flight hardware and what hardware qualifications methods will be used to ensure the hardware is ready for flight. Dennis Webb suggested that ARISS designate a NASA representative to be accountable to ISS program office. This representative will serve as the point of contact or liaison between those that are qualifying the hardware and the ISS program office. Mr. Webb suggested that Matt Bordelon (from his directorate) and/or Carolynn Conley serve in this role. As the hardware gets close to flight, the liaison will provide frequent reporting to the program office regarding development and qualification status.

There were some discussions as to whether ARISS should be qualified as a payload or as Government Furnished Equipment (Crew Equipment). The hardware should probably be considered as Crew Equipment, but could probably be qualified as a payload. This could be finalized once an official NASA sponsor is determined. Mr. Webb requested that Matt and Carolynn consider the Crew Psychological Support group as a potential sponsor for ARISS, since a similar arrangement is set up in Russia.

The ARISS delegations from the US, Germany and Russia all described their vision for ARISS and how it will serve as a focal point for all Amateur Radio development and operations for NASA, Energia, ESA and NASDA. These discussions were well received by the NASA officials. The ARISS international partners painted a consistent description of the importance for the ARISS team to work together and our strong desire to develop, deliver and operate a SINGLE Amateur Radio system on ISS. Frank Bauer stated that the independent, but common descriptions of the ARISS vision presented by these individuals from different countries and from different cultures illustrate the tremendous amount of teamwork and understanding that the ARISS international partners possess.

Mr. Webb suggested a strategy to make ARISS official in the eyes of NASA and Russian Space Agency officials. This would require a change to ISS Specification (ISSP 4100) and the development of a MOU to recognize ARISS as an official activity within the ISS Program Office and to establish a technical team (ISS HAM) that will coordinate the development, qualification and operation of ARISS on ISS.

ARISS Team Follow-on Discussions

The ARISS team spent the rest of the day defining what specifically would be included in the NASA/Energia MOU and in the Technical Team charter. An action was taken by Frank Bauer and Ron Parise to develop a draft MOU and a draft Technical Team Charter. Based on the notes from these discussions, drafts of these documents have been generated and are attached. The team also discussed the responsibilities and interactions of the ARISS international partners and their interactions with the Technical Team. All agreed that ARISS

Table 4. Antenna Systems Required

Destination	Handrails	High Fidelity Antenna System	Volumetric System	Clamp
SM (flight article)	4	3 VHF + Glisser 1 HF + Glisser 1 Spare HF + Glisser 1 Spare VHF + Glisser		4
Integrated Stand	4	3 VHF + Glisser 1 HF + Glisser 1 Spare HF + Glisser 1 Spare VHF + Glisser		4
Hydro Lab	4		3 VHF + Glisser 1 HF + Glisser	4
Training Russia		1 HF + Glisser 1 VHF + Glisser		2
Training U.S.		1 HF + Glisser		2

AMSAT Symposium Field Trip Planned to QUALCOMM and SpaceDev

Symposium Chair, Duane Nagle, KO6BT reports that a field trip is planned on Sunday morning for participants of the 17th AMSAT Annual Meeting and Space Symposium. Two local businesses in the San Diego dealing with satellite communication and spacecraft will open their doors for AMSAT members. QUALCOMM, Inc. has been developing and marketing their Globalstar product to provide satellite telephone service. The actual tour will depend on the specific activities taking place at the San Diego Test Bed that are used to characterize and test the entire Globalstar system including satellite antennas, RF subsystem, and call processing. If available the tour will visit inside one of the three Radomes containing a 5.5 meter dish antenna used for tracking LEO satellites, the San Diego Test Bed Lab/Gateway and the satellite phone lab which includes a demonstration of satellite phones in operation

Afterwards, the field trip will continue to SpaceDev, Inc. whose is involved in a venture of long-term commercial space development and exploration. SpaceDev intends to develop and manufacture spacecraft, launch vehicles and provide a complete line of services from assembly and launch integration to ground stations and mission control. SpaceDev are currently working on a contract at their new San Diego facility and participants will have to wait until October to see exactly what is available.

To registar for the AMSAT Symposium field trip, simple complete the registration form provide on page 33 of this issue. Questions concerning the field trip and other activities associated with the 17th AMSAT Annual Meeting and Space Symposium can be addressed to Duane Nagle, KO6BT at ko6bt@amsat.org.

should be the sole coordinator of hardware development and qualification and the sole coordinator of amateur radio operations on ISS. In addition, everyone agreed that individuals that wish to develop and/or operate amateur radio equipment on ISS should coordinate their ideas with the ARISS representative from their country. During these discussions, Sergej Samburov confirmed his strong desire to work with the ARISS international partners to develop a single, coordinated amateur radio station on ISS. The ARISS hardware team discussed and reaffirmed their long planned commitment to solicit proposals from the amateur radio community to develop follow-on amateur radio hardware for ISS. Proposals chosen to proceed forward would then be coordinated through the NASA/Energia employee-based ISS Ham Technical team that would negotiate with NASA for power, volume and operations scenarios for the proposed equipment.

The rest of the day and most of the following morning (Wednesday, 27 January 1999) was spent discussing some of the international issues that have arisen recently regarding amateur radio development on ISS. Moreover, the team discussed individually and collectively how we can ensure that these problems, which have resulted in much confusion in ARISS, NASA, and Energia, do not occur in the future. These discussions all led to the same conclusion that the problems that have occurred were due to individuals who do not want to work within the ARISS development and operations framework. Despite all their good ideas, they wish to bypass ARISS to jumpstart their plans ahead of ARISS. All agreed to provide opportunities for ALL to participate in ARISS; however, amateur radio's future DEPENDS on ARISS providing an amateur radio focal point to NASA, Energia, NASDA and ESA. We agreed to discourage practices that require working around the ARISS framework. These practices will compromise crew safety and will jeopardize amateur radio's future on ISS. The amateur radio community will never forgive the ARISS team if we let ISS slip through our grasp by condoning these practices.

Respectfully Submitted,

Frank H. Bauer, KA3HDO

ARISS Administrative Chairman

AMSAT-NA Vice President for Human Spaceflight Programs

NASA Goddard Space Flight Center ■

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Observations from Norway

John Hackett, LA2QAA (la2qaa@amsat.org)

9600bps

For some time now I've been *messing* with various circuits for a decent tuning scope for the 9600bps satellites.

Perhaps I should explain, for the benefit of the newcomer to digital satellite communications, unlike the 1200bps *PACSATS* or terrestrial packet for that matter, there's only one *slight* problem. YOU CAN'T HEAR 'EM!.

For those not affluent enough to own an oscilloscope one method of *tuning* in these birds is to set your squelch to the threshold point and wait for the signal to break the squelch. You can then watch your S-meter in conjunction with a suitable satellite tracking program, preferably one showing the actual receive frequency with Doppler shift accounted for.

If you are like *LA2QAA* and own a small 70cm rig with an S-meter the size of your thumbnail, you'll realise why I've been *messing* with various tuning meter circuits, without too much success I might mention. All *worked* after a fashion, but I wasn't really satisfied with the results.....and then I had a (rare) flash of brilliance!.

It's a well established fact that *LA2QAA* is about as **thick** as they come. It is also a well known fact that there is a *very* fine line dividing *genius* from *total idiocy!* (Aye, we had noticed.....*GM1SXX).*

Recently, I've been doing some experimenting with **AMTOR** via satellite using the well known **HAMCOMM** software and interface. It suddenly struck me! The HAMCOMM software has a built in *full screen* tuning scope as well as a full screen spectrum analyser/bit length facility. Why not try these with the 9600bps satellites? So I did! I connected up the single op-amp interface to my spare 386 PC with a B&W monitor, audio fed to the interface directly from the discriminator of the 70cm rig, tuned to a *UO-22* pass and watched the screen.

As a very good friend of mine would have said.....I was gobsmacked! (For our American cousins:..... "I was quite surprised.")

Not *quite* as good as a (very expensive) dedicated oscilloscope but for the price of 1 x 741 op-amp, 4 x 1N4148 diodes , 2 capacitors and two resistors it really is something those with a 9600bps interest should check out. The secret is of course the *excellent* **HAMCOMM** software by W. F. Schroeder, DL5YE. *(Bet he never envisaged it being used for the 9600bps satellites!)*

More on 9600bps

Here's a *lesson* for those operators like LA2QAA who do **not** pay attention to the *more haste, less speed* theory.

On setting up my modem for 9k6bps I found I had no RECEIVE despite a strong signal from the satellite. Couldn't find *the fault* anywhere so I *ripped* out the 9k6 modem from the TNC and tried it at 1200bps. Perfect! I then reinstalled the 9k6 modem and still no receive. I still couldn't find the fault. After three (3) days of headscratching, I decided to confirm I actually *did* have a 9k6 signal from the discriminator of the rig.

(Standard modification for a TR-851E is a connection from pin 9 IC2 to an 0.1uF capacitor).

I opened the rig, looked at the IC 2 pins.....1. 2. 3. 4. 5. 6. 7. 8. 9. connection to pin 10.....ten?? It's supposed to be 9! Relocate RG-174 coax and 0.1 capacitor to pin 9....diode probe test using *white noise.* Ahhh!, now we have 9k6 from the discriminator.

WE HAVE NOW ESTABLISHED THAT LA2QAA CAN'T COUNT TO MORE THAN 8 BEFORE GETTING IT WRONG.

Moral of the Story

When performing modifications take your time! And read the instructions *carefully.* (NB. I'll bet you there was nothing wrong with the 9k6 modem at all!)

The Price We Pay

The price we pay to operate satellites. After having established I was *receiving* the 9600bps birds like *nobody's business* the next step was connecting to them. This turned out to be a bit more difficult than I'd imagined. Being the proud owner of two beat-up old tin cans for 2m (a TS-700G and an even older MULTI-750A), I thought one of them may be suitable. From past experience I knew the 700G was a bit *iffy* on FM (used exclusively for SSB on FO-20). It was in fact *stone deaf* in the FM mode! Not that this would matter since it transmitted perfectly fine on *AO-27 FM.*

I knew that ordinary FM generated from the microphone amps was a non-starter for 9600bps data operation so I connected the modem directly to the multivaractor in the FM generator via a length of RG-174 and a 68n capacitor. *NO CONNECT!* I *messed* with the deviation a bit but still couldn't get a connection.

Next I looked at the MULTI-750A but I had no circuit diagram for this rig and the circuit boards were *potted* (covered in a dirty brown epoxy type *goo* as hard as rock!). This rig too was a non-starter for 9600bps data.

I was rescued by my *Fairy Godmother* (**don't ask**). Suffice to say the magic wand worked and I'm now QRV with TX as well as RX.

Old Tin Cans

For those of you who still operate the PACSATS on *old tin cans* of the 286 variety, or for any other reason can't operate *WiSP,* I can thoroughly recommend a program called **SATSKED** by WA2N and NZ3F. This is a DOS version of *WiSP* (and I believe, it's predecessor). It's a fully automated tracking and scheduling program that will drive your rotators, change satellites (by itself) upload/download files (while you're doing something the XYL thinks is *useful*). Used in conjunction with *G3RUH's* 9600bps auto-Doppler correction circuit for your 70cm rig and you'll never have to actually *do* anything ever again except type the message!

Personally I find *total* automation quite boring but it has it's uses particularly if *Match of the Day* (British TV program) coincides with a pass from your favourite satellite.

So check it out as the program is available on the AMSAT-NA website. You'll need a registration number in exchange for a small donation to the Phase 3D fund c/o AMSAT-UK or AMSAT-NA.

Experiment

I'd been looking for a more effective groundstation antenna than my dual J-Pole. One that I could use on the 9600bps satellites *without* using my rotary beams. I'd looked at the eggbeater (problems with *Salmonella* in the coax) and the quad helix, Lindenblads *(been there, done that).* Next I looked at the corner reflector and came up with the idea of something similar. A rotatable *Torus* reflector behind a monopole, mounted on a plate that could be tilted mechanically (say between 15 and 35 degrees) by using the relays in my Fodtrack interface. (Yes, but the Fodtrack interface doesn't have relays? *MINE DOES!)*

A Torus reflector is paraboloidal in the horizontal plane and circular in the vertical plane. Originally used in military radar applications having a relatively *wide* beamwidth and and a *low* vertical radiation angle. (It's all in the *angles.*) There is no reason why a Torus can't be made to have a *narrow* beamwidth and a *high* vertical radiation angle...*OR ANYTHING BETWEEN THE TWO.*

The commercial **big boys** use a Torus reflector with 3x microwave heads for tracking geostationary satellites over a fairly wide frequency span. My implementation is for an

antenna with different parameters that will be suitable for tracking a **LEO.**

I'm now waiting for e-mail from Bill Gates to purchase the patent and mass-produce the antenna for use with his next fleet of telephone satellites.

It's an interesting mechanical experiment. Luckily I have a *friendly* metalworker on the mainland who can produce a lightweight frame for the Torus reflector. The actual reflecting material will be lightweight aluminium mesh as used in stressed parabolic dishes. At 70cm the antenna isn't very big and will fit on most balcony corners.

At Last

The latest *trick* in my 9600 bps adventure was importing a modified rig from the UK by courtesy of a very good friend of mine. After nine weeks the Norwegian customs told me I wasn't allowed to import this apparatus. "You have to be a radio amateur!" (I've only been a licensed *Norwegian* radio amateur for 18 years!) Before I could contact the necessary telecommunication administration personnel to *sort them out,* I had another letter to the effect of: "In light of you not being a radio amateur, we have returned the illegal apparatus to the UK etc." The Norwegian customs officials are *not* my favourite people right now.

However, lady luck must have took pity on me because I was offered a small contract job allowing me enough to earn the price of a spanking brand new 2m FM mobile rig for the 9600bps uplink (the RX side has been working perfectly for *yonks*). I've been plagued by *Murphy* for far too long now it was about time that *Percy* put in an appearance (a.k.a. *Percy Verance).* Hopefully, by the time this article hits the presses I'll be plaguing the life out of the world's 9600bps operators (and GM4ULS).

JB

My partner in crime *GM1SXX* recently visited JODRELL BANK in UK and sent me a few pictures (which I appreciated very much). As most people *(should)* know, JB is still one of the world's foremost radio telescopes. It was nice to note that the exterior hasn't changed much in the last 35 years apart from re-surfacing the dish for more accuracy at the *higher* frequencies. Famous for it's giant *dish* and of course the fact that LA2QAA was born within spitting distance of the main array it continues to play a large part in space exploration.

Chuffed?.....(not 'arf!)

Yesterday I purchased a new 2m FM mobile rig to modify for 9600bps. Today 0306990835Z I was *messing* on AO-27 with my dual J-Pole antenna (see the January/February 1997 issue of *The AMSAT Journal*) and created a mini pile-up. Apparently IOTA 36 (Frei Island, Norway) is still popular via satellite. As can be imagined with an FM transponder the QRM was something else! I was having difficulty picking out the callsigns until I heard **W2RS/OE** calling. Everything went *dead* quiet for three seconds...then there was *bedlam!* (Those not knowing **that** callsign should be lined up against the nearest wall and *shot*; unless they're newcomers to AMSAT.) The call **W2RS** is of course held by *Ray Soifer*.....probably the most well known AO-27 operator.....*ever!*. Naturally I was delighted to work Ray and even more so when ten minutes later e-mail *ticked in* from Austria confirming our QSO.

Don't *knock* AO-27 as you never know who may be *lurking* there in the background!

The Bad News

Even with the brand spanking new and carefully modified 2m rig (modification recommended by an expert), I still couldn't get a *connect* to the 9600bps satellites. (*Must* be the TNC.....*GM1SXX).* Therefore, after spending so much time and effort on this project I've finally decided to throw in the towel. *'Bout time too as 75 percent of the AMSAT crew don't use the digital satellites anyway!* Therefore LA2QAA will **not** be seen on the 9600bps birds.

(*Editor's Note: I doubt LA2QAA has thrown in the towel. Certainly many Journal readers will provide him with the much needed advice for a solution. Stay tuned to future Observations for details.*)

The Good News

I decided to try my *portable* **AO-27** station from my previous QTH of Gossen Island. (IOTA EU: 56). Despite good a Norwegian Sea rainstorm, I managed to work Ib Christofferson, OZ1MY with good signals before the *bedlam* started. My *mast* was a three-legged/fold-away microphone stand (a la Mick Jagger, but not as old). The crossboom was a 2m length of dowel. TX is an IC-2100H to a 3-element and RX is a TR-851E fed from a 6-element beam. I use the 3-element 2m beam vertically polarized and the 6 element 70cm beam horizontally polarized. Due to the swivel *fitting* on the microphone stand, I can change this instantly (not that I ever bother on AO-27). The proverbial *wet string* saying is more than adequate.

The next *step* is to set the station up in the center of the town (Kristiansund) on the mainland. I assume I will get the odd look from the passers-by while the antennas are pointing skyward. Particularly if I open a QSO with "*Our Father, which art in heaven.*"

FO-20

My *forays* on FO-20 have been somewhat *sporadic* (pun intentional) of late. Either my signal gets bounced right back at me or more usual shoots off into space at some weird angle where only the occasional extraterrestrial would hear it anyway. I *can* report that thus far I have had no replies from E.T's. Though judging by the amount of overmodulation from certain stations one can but wonder if it is an Earth-based station or E.T. actually answering the CQ's.

What to Do

I've noted that our illustrious AMSAT president is calling for ideas and suggestions for whither AMSAT after 2000 AD. I hope ya'll will make a few sensible suggestions and not vote from the sox down! AMSAT-NA President, Keith Baker,

AMSAT-ZL Satellite Compendium Now Available in North America

Jeff Garrett, ZL1BIV and Ian Ashley, ZL1AOX have recently prepared a satellite compendium CD ROM for AMSAT-ZL members. This CD ROM is packed with over 300 Mb of information on Amateur Radio satellites for use by beginners and experts alike. It is organized into 23 folders containing 858 files on topics that include:

- Images from the Phase 3D Laboratory
- Open Internet URLS for Amateur Satellite Information
- Past Amateur Satellite Bulletins
- Satellite Telemetry Files
- Satellite Tracking Software
- Sound Card Utilities
- Technical Articles on Satellite Topics
- Y2K Satellite Information

AMSAT-ZL has allowed us to make this CD ROM available to AMSAT-NA members via distribution by the AMSAT-NA office. The suggested donation for this CD ROM is $17.50 for AMSAT members and $25.00 for non-members. Proceeds from this project will go to support AMSAT-ZL and AMSAT-NA. To obtain a copy, simply contact Martha at the AMSAT-NA address provided on page 3 of this issue.

NEW SP-2000 & SP-7000 *Heli-Filter SUPER-AMP* PREAMPLIFIERS

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KB2SF recently made a suggestion that there **are** in fact several useful Amateur Radio satellites in orbit. Why not try something new instead of complaining *there's nothing to work* and etc.

Not owning an HF rig for the last couple of years, I decided the easiest way to get back on RS-13 was to build a 2m to 10m receive converter. So I did! If you haven't got the equipment to operate a specific satellite, *beg, borrow, steal, swap, or improvise to obtain* the necessary equipment instead of just walking away and complaining. Look at it this way, *anybody* can push a button and operate the Internet. It takes a bit of *gumption* to operate an Amateur Radio satellite. And *nobody* is as *lazy, broke, or* **thick** as LA2QAA. And if I can do it, so can you!

As usual, criticisms to the editor and FT 736R donations to LA2QAA. Derisive comments accepted providing they're written on the back of 100 dollar bills.

73 and med hilsener fra,

John Hackett, LA2QAA, Torvveien 10, N-6520, Frei, Norway ■

Satellite Orbital Elements

by Ray Hoad, WA5QGD

Satellite	AO-10	FO-20	RS-12/13	AO-27	RS-15	FO-29	UO-11	AO-16
Catalog Number	14129	20480	21089	22825	23439	24278	14781	20439
Epoch Time	99197.91479915	99203.03262857	99203.14693609	99203.24520102	99204.82718224	99205.41573378	99203.44678754	99203.18925469
Element Set	580	158	180	739	399	261	173	250
Inclination	27.1421	99.0218	82.9219	98.4555	64.8171	98.5651	97.9343	98.4812
RA of Node	19.456	31.1166	71.3227	266.7617	353.1541	151.5928	168.9424	280.6547
Eccentricity	0.602022	0.0541116	0.0029094	0.0008833	0.0158725	0.0351706	0.0012899	0.001184
Arg of Perigee	331.0198	85.5934	330.8324	149.3011	346.3459	357.9234	79.593	112.356
Mean Anomaly	5.823	280.6759	29.1205	210.8689	13.3244	2.0429	280.673	247.8882
Mean Motion	2.05867179	12.83254503	13.74139005	14.27914011	11.27533157	13.52674427	14.70566126	14.30224284
Decay Rate	0.00000064	-0.00000009	0.00000082	0.00000095	-0.00000016	-0.00000029	0.00000683	0.00000136
Epoch Rev	12100	44280	42421	30324	18837	14484	82367	49557
Satellite	DO-17	WO-18	LO-19	UO-22	KO-23	KO-25	IO-26	TO-31
Catalog Number	20440	20441	20442	21575	22077	22828	22826	25396
Epoch Time	99205.26459712	99203.18517851	99203.15738256	99205.54233794	99203.88784185	99204.18838288	99205.18432437	99205.77211681
Element Set	246	264	254	959	846	716	736	171
Inclination	98.489	98.4878	98.4935	98.1898	66.0788	98.4535	98.4585	98.7596
RA of Node	284.2314	281.9783	283.1673	244.2865	341.9833	268.296	269.1267	279.0709
Eccentricity	0.0011894	0.0012688	0.00127	0.0008419	0.0010324	0.00103	0.000897	0.0000597
Arg of Perigee	106.0894	113.9294	110.4183	103.9084	214.4557	130.2433	145.5073	182.9234
Mean Anomaly	254.1597	246.3221	249.8367	256.3041	145.5793	229.9643	214.6684	177.1944
Mean Motion	14.30383094	14.30328968	14.30457443	14.37349777	12.86324973	14.28407898	14.28038162	14.22396278
Decay Rate	0.00000125	0.00000142	0.0000009	0.00000179	-0.00000037	0.00000116	0.00000088	-0.00000044
Epoch Rev	49591	49561	49564	42070	32623	27155	30354	5396
Satellite	GO-32	SO-33	PO-34	SO-35	UO-36	MIR	ISS	Phase 3D (est)
Catalog Number	25397	25509	25520	25636	25693	16609	25544	999934
Epoch Time	99203.19701911	99203.68067632	99204.39623786	99205.87345192	99203.86018375	99205.83007728	99205.49340628	96260.25520000
Element Set	193	67	83	81	45	702	785	3
Inclination	98.7588	31.4433	28.4624	96.4839	64.5617	51.6601	51.595	60.0203
RA of Node	276.4187	312.6641	211.3154	124.4123	36.3625	151.0643	10.1628	342.7876
Eccentricity	0.0001742	0.0367865	0.0007181	0.0154103	0.0012498	0.0005245	0.0010455	0.6752895
Arg of Perigee	5.1376	83.6585	340.6966	135.4345	344.5578	343.8513	130.0358	180.1221
Mean Anomaly	354.9821	280.5803	19.3352	225.9353	15.5126	16.2215	230.1552	179.5059
Mean Motion	14.22257349	14.239991	15.03805902	14.40890195	14.7329742	15.73447238	15.60366151	1.51063698
Decay Rate	-0.00000044	0.00000354	0.0000115	0.00000177	0.00000135	0.00028701	0.00018007	0.0002
Epoch Rev	5361	3867	4016	2180	1363	76733	3842	2

AMSAT Journal Telemetry

Donald L. Stoner, W6TNS, SK

AMSAT members throughout the world were saddened to learn that the man who conceived of Project OSCAR, Don Stoner, W6TNS, of Clearwater, Florida died 4 May 1999 at the age of 67. Stoner reportedly had been in ill health for some time and he reportedly suffered a ruptured aneurysm.

In 1960, Stoner, then living in Alta Loma, California, was the idea man behind Project OSCAR. Stoner outlined his concepts for an Amateur Radio space program in the February 1961 issue of *QST* (see *Project OSCAR—Something of the Future*). In his prophetic article, Stoner envisioned a two-phase project, the first to launch an orbiting VHF beacon transmitter into space, the second to launch an *orbital repeater*. Approximately one year later, OSCAR 1 was launched on December 12, 1961.

A Flint, Michigan native, Stoner developed an early interest in electronics, according to longtime friend Merle Parten, K6DC. Stoner's father, Lew, was W8IMS. Don Stoner went on to enjoy financial success in the commercial world. In the Citizens Band heyday, he was a manufacturer of CB transceivers. Later, he founded a company that developed systems to back up bank records and to telephone overdue accounts. He retired in 1989.

An AMSAT and ARRL member, Stoner also will be remembered as a CQ columnist—he served in several editorial capacities, including VHF editor, Novice editor, surplus columnist and semiconductor columnist—and as founder of the unsuccessful National Amateur Radio Association. Stoner also wrote the *In Theory* column in *CQ VHF* magazine in 1996 and 1997.

More recently, Stoner had become a guru for amateurs battling restrictive covenants to install antennas.

AMSAT President, Keith Baker, KB1SF, commented that AMSAT has now lost one of the true visionaries from among our Amateur Radio Satellite ranks. There can be no doubt that Don Stoner's ideas were light years ahead of his time. The more than 36 OSCARS and other Amateur Radio satellites built and successfully launched since his words first sparked the creation of the Original Project OSCAR back in the early 1960's, have now become a living testament to that simple truth.

Stoner's wife, Lucy, and two sons are among his survivors. Services were held 7 May 1999 in Clearwater, Florida and a memorial service and interment were held 11 May 1999 in Kirkland, Washington.

Don Stoner's Idea

Over forty years ago, Don Stoner, W6TNS wrote an article in CQ titled "Semiconducters" that provided the catalyst for the Amateur Radio satellite program. The following excerpts are taken from an article by William Orr, W6SAI, titled "Sixty Years of Radio Amateur Communication." This article appeared in the February 1962 issue of QST and it certainly captures the spirit and accomplishment of W6TNS' brainstorm that still fuels AMSAT members in 1999.

February 1959: The radio amateur gazed thoughtfully for a moment at the white paper in his typewriter. Suddenly his fingers sprang into action and the keys flashed the fateful words, "Currently being tested is a solar powered six- to two-meter transistor repeater which could be ballooned over the Southwest. Can anyone come up with a spare rocket for orbiting purposes?...73, Don, W6TNS." He slapped the page from the typewriter, setting into motion a chain of events that conclusively proved that truth is indeed stranger than fiction.

Of the thousands of readers of Don Stoner's article, none was struck more forcibly than Fred Hicks, W6EJU, of Campbell, California. An old-timer in the communications game, Fred was now employed by a large missile contractor in the San Francisco bay area. Fred had been present in the blockhouse at Vandenberg for the first six Discoverer launches. To Fred goes all the credit for grasping the true nature of Don's message, and interpreting it in terms of the full spirit of Amateur Radio.

Fred dropped the magazine on his desk, pushed aside a cup of coffee and reached for the telephone. He dialed a number and listened to the automatic stepping switches go through their complicated dance in the earpiece of the instrument. "Hello, Chuck? ...Hey buddy, did you read Don Stoner's article this month? ...Well, he said in effect that radio hams could build a satellite if they could only find someone to launch it for them ..." The man on the phone cracked. "Right! That's what I was thinking. Why don't you drop Don a line and get this thing organized?... If old K6LFH and W6EJU and their buddies can't do the job, nobody can!" Chuck was right. Why not build a ham satellite? The idea wasn't so crazy after all. A lot could be learned from such a device. The satellite would...it would...well...Fred suddenly realized that such a simple, beguiling idea could not be defined and would entail a lot of work and planning to even begin to be coherent. Obviously it was a fine project for a club, or a group of hams. One ham couldn't handle this "brainbuster." As H.P.M., the Old Man, might have said, "It was truly an idea without a handle to grab it." Truly, W6EJU was blessed with the spark of adventure.

13 October 1959: "Dear Don: I remember you wrote an article for CQ some time ago that described a small transistorized two-meter station and appealed for 'anyone with a space vehicle, please?'... Though I do not hold out any too much hope for this, I will do my best to interest certain parties. Please send me the exact weight of the installation and space it occupies...Actually, the 'Discoverer' is ideally suited to such a ham project. I will sound out the local hams...look for me on 14,285 kc...73 and I certainly hope we can pull this off!...Fred, W6EJU."

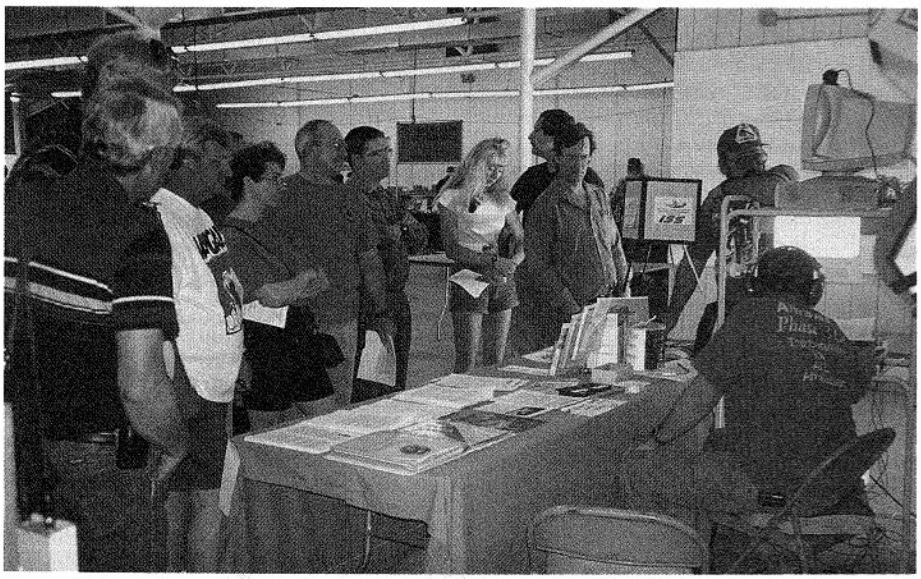
The die was cast. The spark of adventure had found fuel and was burning brightly. The fateful letter was on the way; was in the mail. It would start a thousand minds dreaming and planning, and the concept would eventually involve high level decisions in the U.S. Government. Now, at this moment in time it was a gossamer; a fancy that might be lightly discarded as a mere exercise of the imagination. (After all, why not? Would not a homemade satellite be yet another convincing proof that Amateur Radio was indeed in the public's interest, convenience, and necessity? At the very least it would be a self-educational program, introducing the great body of amateurs to space communications. Of course.)

15 October 1959: "Dear Fred: To say I was elated to receive your letter would be the understatement of the year. However, before I allow myself to get too excited, I am going to submit a proposal to you and see what happens...As you say, I hope we can pull (or is it push) this thing off. Best regards, Don."

The radio amateurs seated around the conference table grinned as Fred, W6EJU, Chairman read the message. The first meeting of the OSCAR committee was about to be called to order. There were: Chuck Towns, K6LFH; Bernie Barrick, W6OON; Stan Benson, K6CBK; and Nick Marshall, W6OLO. These amateurs were the trail-blazers into space in the year 1959!

In Los Angeles, Don Stoner had many conversations with Ray Meyers, W6MLZ, and Henry Richter, W6VZT. Gradually a concept of a suitable radio satellite package was being pounded out. The phone bill between W6TNS and W6EJU began to grow to alarming proportions, supplemented by sideband schedules on 7 Mc. Don suggested that the rapidly growing group of hams be called the OSCAR Association: *Orbiting Satellite Carrying Amateur Radio*! A natural name. So was OSCAR born in spirit.

The diligent efforts of the OSCAR Association paid off when on 12 December 1961, at 2042 UTC, Discoverer XXXVI was launched into orbit from an Agena-Thor rocket from Vandenberg Air Force Base, carrying into separate orbit OSCAR 1. This was the first of many Amateur Radio satellites that have rode to orbit on the thoughts, innovation, hard work, and prayers of thousands of radio amateurs who continue to stand on the threshold of tomorrow. Thanks Don.



Working AO-27 from the AMSAT Booth, Al Lark, KD4SFF captured the attention of many Upstate Hamfest participants.

ARRL Honors SETI League Director

The American Radio Relay League, has honored Dr. H. Paul Shuch with a Technical Achievement Award, in recognition of his nearly forty years of service to the amateur radio community. Shuch, who holds Amateur Radio callsign N6TX, has served since its inception as executive director of the membership-supported SETI League, Inc., grass-roots leaders in a privatized Search for Extra-Terrestrial Intelligence. The award was presented on 4 June 1999, at the ARRL Atlantic Division Convention in Rochester NY.

"It's interesting," notes ARRL Atlantic Division Director Kay Cragie, who informed Shuch of his selection, "that this year we also honored Ed Gable, K2MP, as Amateur of the Year. Ed is curator of the Antique Wireless Association museum and is devoted to conserving the history of the radio arts, while our Technical Achievement award winner was the Executive Director of the SETI League. We have the past and the future appropriately honored in our turn-of-the-century awards."

An active AMSAT member, Dr. Shuch credited with designing the world's first commercial home satellite TV receiver, developed early weather satellite receivers, and holds patents for aircraft radar systems. An Extra-class radio amateur first licensed in 1961, N6TX has been operational in all 20 ham bands between 1.8 MHz and 24 GHz, and is now operating a 1.42 GHz radio telescope. Paul has chaired the VHF/UHF Advisory Committee of the American Radio Relay League, and served as Technical Director and Board Chairman of Project OSCAR, Inc., designers of the world's first non-Government communications satellites. He has served as a Director of the Central States VHF Society, and was Banquet Speaker at the 1996 Dayton Hamvention. Paul was a college professor for 24 years, and is the author of more than 200 publications. His honors include the National Space Club's Dr. Robert H. Goddard Scholarship, a Hertz Foundation Fellowship in the Applied Physical Sciences, the Hertz Doctoral Thesis Prize, and the Central States VHF Society's John T. Chambers Memorial Award. He is a Fellow of the British Interplanetary Society, serves as a fellowship interviewer for the Hertz Foundation, is a manuscript reviewer for several peer reviewed journals, has been an advisor to the National Science Foundation, and is a military program evaluator for the American Council on Education.

SETI scientists seek to determine through microwave and optical measurements whether humankind is alone in the universe. Since Congress terminated NASA's SETI funding in 1993, The SETI League and other scientific groups have been attempting to privatize the research. Experimenters interested in participating in the search for intelligent alien life, or citizens wishing to help support it, should email to *join@setileague.org*, check the SETI League Web site at *http://www.setileague.org/*, send a fax to 1 (201) 641-1771, or contact The SETI League, Inc. membership hotline at 1 (800) TAU-SETI. Be sure to provide them with a postal address to which they will mail further information. The SETI League, Inc. is a membership-supported, non-profit [501(c)(3)], educational and scientific corporation dedicated to the electromagnetic Search for Extra-Terrestrial Intelligence.

Al Lark, KD4SSF (right) presenting AMSAT Human Space Flight VP, Frank Bauer, KA3HDO with donated ARISS proceeds from the Upstate Hamfest.

AMSAT Members Raise ARISS Funds at Upstate Hamfest

A week before the Dayton Hamvention, Fred Tuck Jr., WD4KTI and Al Lark, KD4SSF worked an AMSAT booth at the Upstate Hamfest held at the Anderson County Fairgrounds, in Anderson, SC. At the booth, they held a drawing for a Logitec Quick Cam and an ARRL Satellite Experimenter's Handbook, that raised $100.00 for the ARISS project. A week later at the Dayton Hamvention, Al presented AMSAT Human Space Flight VP, Frank Bauer, KA3HDO with a check for $100.00.

In addition to fund raising, Fred and Al also generated a lot of interest in AMSAT (specifically the SAREX, and the ARISS programs). Al operated AO-27 for a satellite demonstration,

working a 60-degree maximum elevation pass. They used NOVA satellite tracking software for the crowd to see the location of AO-27. During the AO-27 pass, Al used a Yaesu FT-847 connected to a pair of M2 Eggbeaters located on the roof of his motor home which was parked just outside the hamfest door. The on-lookers were quite surprised to hear stations calling for KD4SFF, before Al even transmitted. However, a couple of days earlier, Al had put out a message, on the AMSAT-bb, stating that I would be operating *KD4 Satellites For Fun* on AO-27, from the Upstate Hamfest. Everyone on AO-27 was kind enough to let Al have the frequency. As a result, Al was able to work five stations: Steve Gocala, KB8VAO, Youngstown, OH; Mike Seguin, N1JEZ, Burlington, VT; Anna Stevens, WF4Z, northeast TN; Ken Chaffee, WA1QXR, Ashaway, RI; and Malcolm Preston, NP2L, Cruz Bay, VI.

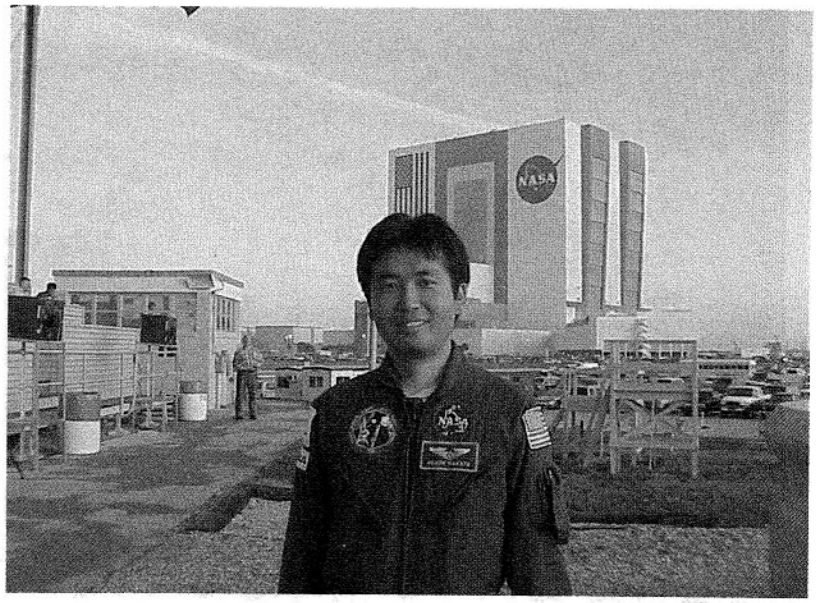
KE4ZXW Special Event Station

The Virginia Air and Space Center (VASC) Amateur Radio Group will be operating special event station KE4ZXW from the VASC in Hampton, Virginia to celebrate four years of automatic station operation of 9600 baud amateur satellite and radio exhibit. The special event station will be held on 25-26 September 1999 from 0000 – 2400 UTC using UO-22 and KO-25 satellites. HF operations will take place from 1500 to 2100 UTC on 7.265 MHz at :00, 14.265 at :15, and 28365 at :30. QSL via SASE to Ed Brummer, W4RTZ, 108 Oyster Cove Road, Yorktown, VA 23692.

VOXSAT-1 News

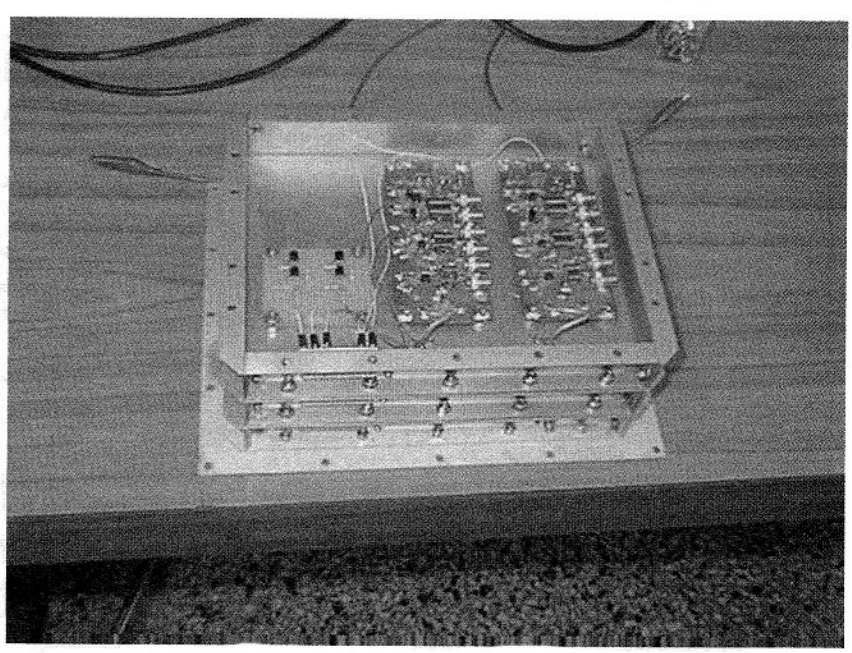
AMSAT-LU continues efforts to prepare VOXSAT-1 for integration to a Russian satellite for V/U Amateur Radio operations. VOXSAT-1 will also contain a digitalker that will provide random one minute of uplink recordings from satellite operators. The satellite will also provide Amateur Radio satellite capabilities similar to the now inoperatable AO-21. Some of VOXSAT-1 characteristics are:

- **Orbit:** 1000 km polar orbit with maximum pass duration of 20 minutes
- **Transmitters:**
  - Telemetry, broadcast, and parrot transmitter: 2.5 watts
  - V/U Repeater: 4.0 watt
- **Operation Modes and Frequencies:**
  - Digipeater and Telemetry: 145.990 MHz, FM
  - Mode V/U Repeater: 145.910 MHz FM (downlink) – 435.990 MHz FM (uplink)
- **Power:**
  - Solar panels: 28 Volts
  - Regulated source: 10 volts for satellite, 5 volts for logic circuits
- **Internal Housekeeping Unit:**
  - PIC 16C55 for command with 1 Kb ROM
  - PIC 16C71 with 1 Kb and four A/D channels
- **Telemetry:** CW at 25 wpm transmitting
  - Channel 1 = Voltage from main source
  - Channel 2 = Voltage from logical source
  - Channel 3 = Voltage from RF module
  - Channel 4 = Temperature of logical module

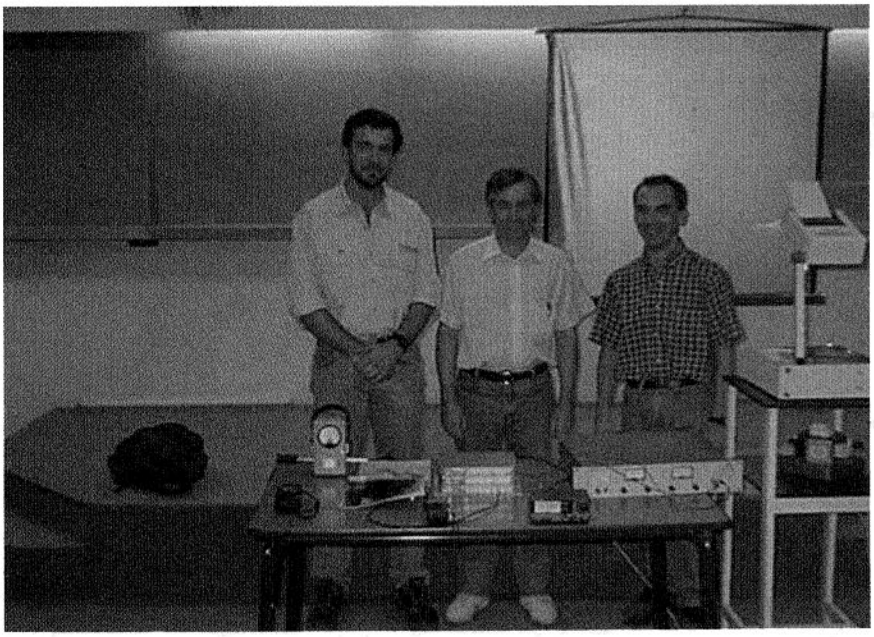


Japanese Astronaut Koichi Wakata, KC5ZTA recent attended the launch of STS-96 *Discovery* from the Kennedy Space Center, Florida with Phase 3D Integration Manager Lou McFadin, W5DID. *Discovery* completed a very successful 9 day mission to the International Space Station, setting the way for STS-101 mission that will include the delivery of ARISS equipment to the International Space Station. Wakata commented that he looks forwards to the opportunity to operate ARISS equipment from the International Space Station. (Photo by Lou McFadin, W5DID)

AMSAT-LU will provide a certificate to those who donate US $10 or more for VOXSAT-1 funding. Those who donate $100 or more will have their callsign included on the satellite. Donations may be sent to AMSAT-LU, c/o Gustavo Carpignano, LW2DTZ, P.O. Box 187, 1401 Buenos Aires, Argentina. Further VOXSAT-1 information can be obtain via *http://members.xoom.com/Amsat_LU.*



A view of the upper section of VOXSAT-1containing the excitation source and ignition unit. (AMSAT-LU photo)



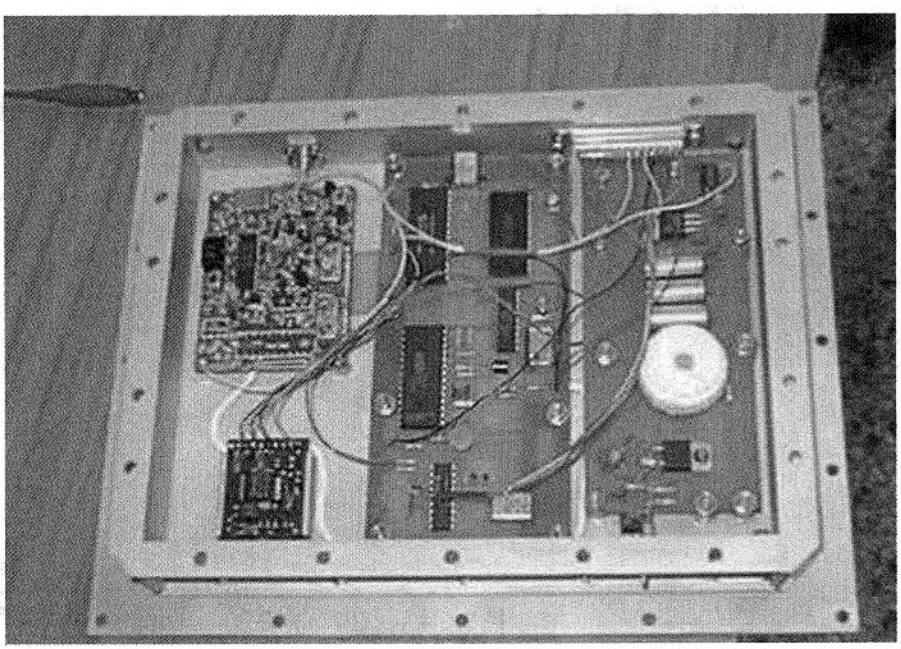
Vacuum and vibration testing of VOXSAT-1 testing took place at the National University of Comahue, Argentina. From left to right are Alejandro Alvarez, LU8YD, VOXSAT Project Leader Gustavo Carpignano, LW2DTZ, and Jorge Lassig, Director of the Pehuensat Program, Comahue University. (AMSAT-LU photo)

An AO-27 Proposal by Bob Bruiniga, WB4APR

AO-27 is one of the most popular AMSAT's because it allows hand-held *voice* communications. As part of my focus on using satellites for mobile/portable Amateur Radio operations, this proposal suggests ways to improve the visibility of such operations by tying the AO-27 downlink into the internet and WWW pages so that everyone can monitor the activity. This is very useful Amateur Radio outreach for students of all ages.

All we need are a few stations monitoring the downlink and feeding it into the internet for access. These ground stations need only an UHF receiver and fixed antenna. Only 9 or so stations would provide 90 percent coverage for all passes over the USA. There are two types of information on the downlink: voice and *occasional* APRS MIC-E tone bursts. The APRS MIC-E PTT tones here are only the 0.2 second ID burst that can be appended to the end of any voice QSO by the new Kenwood THD7 dual band 5W HT or from any radio using the APRS Mic-Encoder. First I will address this tone burst since it is the easiest.

The 0.2 second tone bursts contain the station's position, course, speed and brief status. NOTE! These bursts are not normally used on AO-27, but are useful for demonstrations and emergency communications from wilderness and other remote users. We are *not* suggesting packet operations on AO-27, but these computer-readable bursts are invaluable in the rapid and precise identification of users. On the ground, these bursts can be distributed worldwide almost instantly by the existing APRServe Internet infrastructure and instantly plotted on many *live* WWW pages such as *http://www.aprs.net* . Thus, not only do we have a self logging satellite voice communications system, but also the ability to receive emergency text communications from anyone with an HT via AO-27 (as well as any other FM voice or AX.25 satellite such as *Mir*).



VOXSAT-1's lower section containing telemetry and switching sources. (AMSAT-LU photo)

Since there will be multiple receiver station sites all feeding their data into the same worldwide distribution system, they can use fixed antennas and frequencies and only concentrate on their optimum area of the sky because:

- AO-27 is only on during the day, during descending (North to South) passes
- During the first third of the pass, the Doppler is about +7 kHz

Thus, a fixed tuned receiver at 435.807 MHz (+7 kHz) using only a 3 element UHF beam or corner reflector pointed north will capture almost HALF of the available passes. Higher gain is *not* desired since it would not see passes to the northeast and northwest. Remember, your station is only a small piece of a nationwide distributed listening network. The geometry of the sky from your location where the Doppler is between +6 and +8 kHz extends from your northern horizon to almost 45 degrees. The sector is a full 90 degrees wide from your NE to your NW. No more than 3 elements should be used or the azimuth coverage would not be sufficient. If you want to pick up an added 3 dB, then use a pair of stacked 3 element vertical beams to narrow the vertical pattern while preserving the horizontal width. Other creative antennas approaching 10 dB can be designed for just this sector.

Operations: Any such UHF receiver configured as noted above, will receive the downlink during all daytime passes. To link those brief 0.2 second tone bursts from the THD7 users into the worldwide APRS Internet system, all you must do is have a TNC with the MYALIAS of RELAY listening on UHF and transmitting on 2 meters on 144.39 MHz.

Voice Internet Access: This is not my area of expertise, but I assume that using *REAL-AUDIO* techniques, that creative Webmasters can create WWW pages to capture and make available the brief 5 minute pass audio from their receiver to anyone in real time.

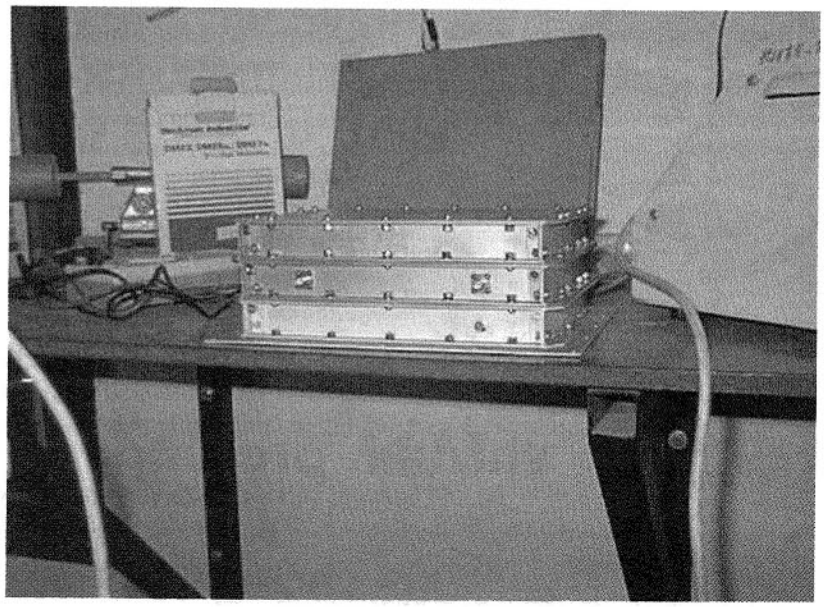
Future Plans: I will begin work on such an AO-27 monitoring receiver station for Maryland. Just looking at a USA map, if we had similar sites in Atlanta, Chicago, Miami, Houston, Kansas

City, Denver, LA and San Francisco we would have quite a network, capable of capturing most passes. Already you can monitor such live HT users via *Mir* on our automatic *Mir* monitoring WWW page: *http://web.usna.navy.mil/~bruninga/mirex.html* This is a similar system to monitor the AO-27 downlink.

Kenwood TH-D7 Users: To enable the short tone burst at the end of your PTT voice operations, set TRANSMIT to PTT, rate to 30 secs, PATH to RELAY. Keep your STATUS text short or your data burst will be longer. You can dial in any one of the 7 pre-programmed COMMENTS, but please avoid EMERGENCY unless its true. Uplink is on 145.85 MHz. The internal TNC cannot operate cross band, so you will *not* be able to decode any other stations you may hear on 435.800 MHz + Doppler shift. But everyone else monitoring can.

If you do not have a THD7, you can add a Mic-Encoder to any HT using either the original TAPR Mic-ENcoder or the new Mic-Lite. See *http://www.toad.net/~clement/mim2.htm*

Please provide your comments on this proposal to *wb4apr@amsat.org*.



A complete view of VOXSAT-1's three sections. Note the antenna connectors in the middle section. (AMSAT-LU photo)

Sputnik 41 and *Mir* News

Jean-Louis Renault, F6AGR has informed the *The AMSAT Journal* staff that AMSAT-France has answered all of the QSL cards they received from all over the world after the release of Sputnik 41 from *Mir* in late 1998.

F6AGR writes that AMSAT-France would like to thank all who sent SP-41/RS-18 listening reports and patiently awaited an answer. Over 1200 reception reports were received, including touching postcards from a six year old SWL as well as very valuable, detailed, and accurate telemetry records from many Amateur Radio satellite experts.

Also AMSAT-France sends thanks for the countless encouragements, collection stamps, green stamps, postcards, posters, stickers, pins, tourist maps and even flags they received from all over the world. AMSAT-France completed preparing all of the QSL cards in late June during a dedicated BBQ party. The cards were mailed the first week of July with a philatelic postmark on the envelope.

Meanwhile, Sputnik-41 listeners are encouraged to visit the AMSAT-France WWW site (*http://www.ccr.jussieu.fr/physio/amsat-france/*) to verify they are in our logbook. Also, soon available on the same site will be an EXCEL spreadsheet file that displays all the Sputnik-41 temperature data collected from various sources.

Also note that it is not too late to apply for a QSL card: please just send a listening report including date and time and a self addressed envelope with 2 International Response Coupons to the following address: *AMSAT-F, RS-18 QSL Manager, 14 bis, rue des Gourlis, 92500 Rueil Malmaison, France.*

In closing, F6AGR also notes that AMSAT-F team is currently working on a new educational satellite project and asks that you stay tuned for further details.

Meanwhile in other *Mir* news, Harrison Faust, WW4HF reported a *Mir* voice contact with French Cosmonaut Jean-Pierre Haigneré, FX0STB on 10 June 1999. From his station in High Point, NC, WW4HF and Maxine, KU4KA were monitoring slow-scan television from *Mir* when they heard a conversation with another station. When WW4HF called *Mir*, they responded back asking if they wanted to receive a slow-scan television picture. KU4KA replied and FX0STB was pleased that an XYL responded and that they seldom hear a woman's voice on *Mir* Amateur Radio station. FX0STB then wished them good luck and looked forward to hearing them on future passes.

18th Annual ARRL and TAPR Digital Communications Conference

TAPR President, Greg Jones, WD5IVD reports that the 1999 ARRL and TAPR Digital Communications Conference will be held 24-26 September 1999 in Phoenix, Arizona. This year's

AMSAT-France Sputnik 41 QSL Card.

conference location is just minutes away from the Phoenix Sky Harbor International Airport (PHX).

As usual, this event includes the most important new developments in amateur digital communications including:

- A full day of papers, breakout sessions, and selected topics on Saturday for the beginner to advanced amateur digital enthusiast.
- A banquet with special guest speaker Geoff Baehr, N6LXA, Sun Microsystems Chief Network Officer.
- Three seminars/symposia
  - Friday (1 PM) - Third Annual APRS National Symposium, moderated by Steve Dimse, K4HG, featuring Bob Bruninga, WB4APR, Keith Sproul, WU2Z, Mark Sproul, KB2ICI, Brent Hildebrand, KH2Z, and other APRS developers
  - Friday (5 PM) - Technical Seminar on High-Definition TV (HDTV)
  - Sunday (8:30 AM) - PIC Development, Design, and Programming
- Fourth Annual Student Paper Awards.
- TAPR Membership Meeting
- SIGs (Special Interest Groups) get-togethers on Saturday, following the banquet

For full details on the conference, refer to *http://www.tapr.org*.

Observatory to Honor Amateur Radio Satellite Pioneer K2ZRO

The staff of Kopernik Observatory in Binghamton, NY and Amateur Radio volunteers celebrated the observatory's 25th anniversary 5 June 1999 with a special event that honored the memory of one of the observatory's founders, Kaz Deskur, K2ZRO, who died in 1984. Amateur Radio club station KB2UYF is located at the observatory, and paperwork has been submitted to the FCC to change the station's call sign to K2ZRO.

Deskur, a satellite pioneer, operated the observatory's Amateur Radio station under his call sign for many years. In the early days of the OSCAR program and AMSAT, K2ZRO was a familiar call sign. Deskur designed the original OSCARLOCATOR, a device used to track satellites before the advent of personal computers.

The observances June 5 included a formal dedication of the observatory club station. Deskur's widow and family were honored guests, and the keynote speaker was Dr. Joseph Dervay, NASA astronaut-physician.

For many years AMSAT sponsored an engineering award in Kaz Deskur's honor. A native of Poland and a radio operator there during World War II, Deskur fought in the Polish Underground. After the war, he emigrated to the US, where he worked for IBM. Deskur's son, Andy, is KA1M.

The Kopernik Observatory is establishing a special *Wall of Honor for Amateur Radio Satellites* to honor Kaz Deskur. All hams that knew or worked with him are invited to send their QSL cards for display on this wall. Please send cards in an envelope addressed to Kopernik Space & Science Education Center (KA2CNG-TR), 30 Front St, Binghamton, NY 13905. (*Thanks to John Kray, KA2CNG and ARRL Newsletter* for providing this information.)

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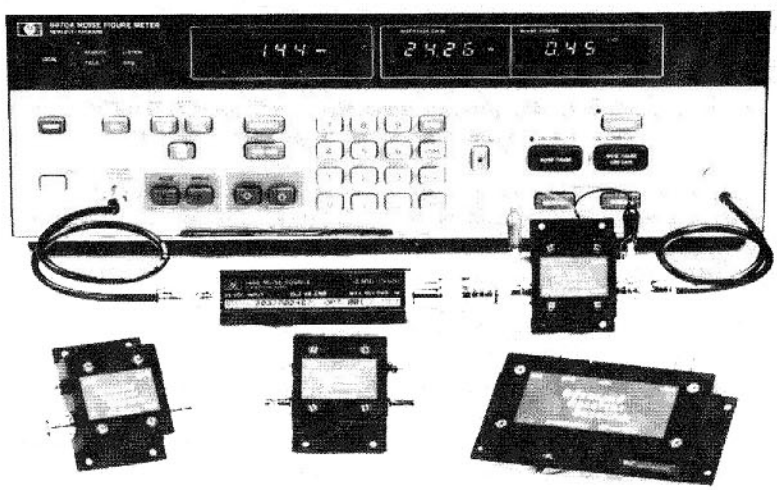

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P28VD	28-30	<1.1	15	0	DGFET	$29.95
P50VD	50-54	<1.3	15	0	DGFET	$29.95
P50VDG	50-54	<0.5	24	+12	GaAsFET	$79.95
P144VD	144-148	<1.5	15	0	DGFET	$29.95
P144VDA	144-148	<1.0	15	0	DGFET	$37.95
P144VDG	144-148	<0.5	24	+12	GaAsFET	$79.95
P220VD	220-225	<1.8	15	0	DGFET	$29.95
P220VDA	220-225	<1.2	15	0	DGFET	$37.95
P220VDG	220-225	<0.5	20	+12	GaAsFET	$79.95
P432VD	420-450	<1.8	15	−20	Bipolar	$32.95
P432VDA	420-450	<1.1	17	−20	Bipolar	$49.95
P432VDG	420-450	<0.5	16	+12	GaAsFET	$79.95
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SP28VD	28-30	<1.2	15	0	DGFET	$59.95
SP50VD	50-54	<1.4	15	0	DGFET	$59.95
SP50VDG	50-54	<0.55	24	+12	GaAsFET	$109.95
SP144VD	144-148	<1.6	15	0	DGFET	$59.95
SP144VDA	144-148	<1.1	15	0	DGFET	$67.95
SP144VDG	144-148	<0.55	24	+12	GaAsFET	$109.95
SP220VD	220-225	<1.9	15	0	DGFET	$59.95
SP220VDA	220-225	<1.3	15	0	DGFET	$67.95
SP220VDG	220-225	<0.55	20	+12	GaAsFET	$109.95
SP432VD	420-450	<1.9	15	−20	Bipolar	$62.95
SP432VDA	420-450	<1.2	17	−20	Bipolar	$79.95
SP432VDG	420-450	<0.55	16	+12	GaAsFET	$109.95

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Sunday morning field trip to Qualcomm, Inc., Globalstar Lab, and SpaceDev, Inc.
http://www.qualcomm.com http://www.spacedev.com

Description	Cost	How Many	Amount
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Until September 15, 1999	$25.00		
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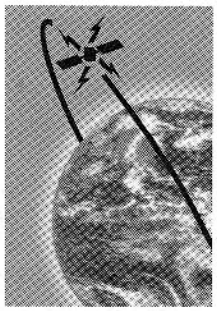

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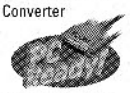

Other options also required for PC connections:

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Mode: ..... SSB, CW, FM
Power: ..... 2M SSB: 6-35W, continuous
2M CW, FM: 6-45W, continuous
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Power Supply Requirement: ... 13.8 V DC
Memory Channels: ..... 160 Total,
80 Channels Per Band
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Size: ..... 9.5(W) x 3.7(H) x 9.4(D) in.
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